JOURNAL

of the

AMERICAN WELDING SOCIETY

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Volume 9 JANUARY, 1930 No. 1

TABLE OF CONTENTS

Society and Related Activities

Page

Bound Volumes ... 3
Instruction Manuals ... 3
Membership Campaign ... 3
Welding of Office Buildings ... 3
Welding in Metal Working Field ... 4
Structural Welding Research ... 5
California Certified Boiler and Elevator Inspectors' Meeting ... 5
Section Activities ... 5
Employment Service Bulletin ... 6

Technical Papers, Items and Reports

Welding on High Pressure Boilers, by Fritz Hofmann ... 7
Bridges Welded in Field on Australian Railway ... 16
Report of Tests Made Upon Welded Joints for Boston Section of the A.W.S. ... 18
How to Weld Galvanized Iron, by A. G. Wikoff ... 23
Welding in the Metal Furniture Industry, by De W. Endicott ... 28
Welding of Galvanized Sheet—Question and Answer Column ... 34
Addition to Lincoln Plant Entirely Arc Welded, by C. M. Taylor ... 35
An Experimental Investigation of the Strength of Welds as Affected by Coatings of Rust, Paint and Oil Upon the Welded Surface, by G. F. Rogers ... 38
Welding Developments in 1929 ... 41
Results of Research in Theory of Arc Welding Machines, by A. F. Davis ... 62
Structural Welding Code Data Applying to the United States ... 65
Specifications for Welding (Activities of A.S.T.M.) ... 73
Current Welding Literature ... 75

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Bound Volumes of 1929 Journal

The bound volumes of the JOURNAL for 1929 are now ready. Members may obtain copies at $5.00 per volume and non-members at $10.00 per volume. The JOURNAL has been bound in attractive imitation black leather covers and includes a "Subject and Authors' Index." A few copies of the volumes for the years 1924 to date are still available. These volumes represent a complete and authentic source of welding information.

Instruction Manuals

In order to meet the demands for a brief treatise of the fundamentals of arc, gas, resistance and thermit processes, instruction manuals have been prepared by an Educational Committee of the American Welding Society. These have been bound together with imitation leather covers and are available at $2.50 per copy.

Annual Meeting

Plans are under way for holding the annual meeting of the American Welding Society in New York on April 23, 24 and 25. Preliminary indications are that this will be one of the most successful annual meetings ever held. A record attendance is expected.

Membership Campaign Extended

At the request of a number of prominent members of the American Welding Society, the Member-for-Member Campaign has been extended from Feb. 1 to March 15.

This will provide an opportunity for those who have as yet been unable to secure their new members to do so. A complete list of those who have met the requirements of the Member-for-Member Campaign will be printed in an early issue of the JOURNAL.

Welding of Structural Steel

There is given elsewhere in this JOURNAL a statement covering cities which permit welding of steel buildings and a list of the more important welded steel structures in the United States. This information has been compiled by the Building Code Committee and represents a cross-section of the advance that has been made by welding in this field in recent years. It is also indicative of the confidence that is being placed in welding by important legislative bodies.

Welding Progress in 1929

In this issue there is published a brief review of the outstanding developments in 1929 as prepared by representative members of the American Welding Society. It is not claimed that this review is complete, but it does indicate the remarkable growth of welding and extension of its applications. The curve of the growth of welding is steeply upward.

The Meetings and Papers Committee invite members of the Society to suggest papers which will bring out additional applications of welding, including such information as technique of welding, selection of material, design data, qualifications of welders or other technical information.

Welding to Be Applied to Office Buildings

Two office buildings, one on the west and the other on the east coast, are soon to be erected with the assistance of metal arc welding. A 13-story structure is to be erected for the Southern California Edison Company in Los Angeles, almost entirely arc welded, and a 14-story structure is to be built for the Boston Edison Company in Boston, also electrically field welded.

It is pointed out by the proponents of welding that these applications

represent noteworthy progress toward the general adoption of this new method of building construction.

The Boston Edison building will be located at 180-182 Tremont Street and will be the first welded building in the city of Boston. W. A. & H. A. Root are the general contractors; the architects are Bigelow, Wadsworth, Hubbard & Smith; the engineers are Whidden Beekman Engineering Company, and Frank P. McKibben, will act as consulting engineeer for the owners and will be responsible for the welding. The building will have 14 stories, will be 60 feet wide on the front, 112 feet deep and 155 feet high. It will have a basement and sub-basement. A total of 1200 tons of steel will be used in the structure.

The two top floors of the Boston building will be occupied by broadcasting station WEEI, thus giving that station the distinction of being probably the first broadcasting station to be housed in a welded building. Two or three of the lower stories, with the basement, will be occupied by stores. The entire field fabrication will be by arc welding.

The Southern California Edison Company building in Los Angeles will have 13 stories, not including a basement and a pent-house, will cover a ground space of 180 by 180 feet and will be 150 feet high. With the exception of the first four stories all steel work will be arc welded. The steel in the first four stories will be partly welded and partly riveted. The architects are Allison & Allison, and the Southern California Edison Company will act as its own engineer. C. C. Watson of the General Electric Company will supervise the welding.

An interesting feature of the Los Angeles building is the special design to provide for the contingency of earthquakes. It is said that the building will be built according to the best standards of modern earthquake design. All of this earthquake bracing will be arc welded.

Another application of welding to the construction of city buildings will be made in Schenectady, N. Y., where a new $1,500,000 city hall is to be constructed by this method. This will be an all-welded structure.

Engineers interested in the application of electric arc welding to building construction point out that the art has now progressed to a point where, in many cases, it is actually less expensive to construct by welding than by riveting. While this has been theoretically possible since the first, shop methods and other developmental details for some time kept the welding cost higher. A number of recent instances, however, involve welding bids which are lower than those covering riveted construction. Engineers explain, in this connection, that the cost of welding is not the only factor involved; the use of less steel is an important item, and there are a number of others, including the elimination of noise in building erection in business sections.

Welding in Metal Working Field

Reprinted from Jan. 23, 1930, issue of *The Iron Age*

Welding applications in the metal-working field are almost bewildering in their number, scope and speed of introduction. It seems but a short time when the chief function of welding, as it emerged from the blacksmith shop, was to patch up castings defective in surface or incomplete in contour. Then the equipment came into vogue to remove gates and risers in the foundry, and shortly we began to see such things as pipe railings assembled with welded connections instead of threaded joints. Gradually there appeared various forms of rolled steel welded into complete machines, or parts of them. That such uses of welding were at first regarded as questionable merely proves how much ahead of current practice the leaders in the welding campaign were. Continued aggressiveness has brought the process into such good repute that the makers of welding equipment no longer stand alone in seeking new welding fields. They have the independent help of plant managers. The fact remains, however, that promotion will largely remain with the welding advocates, and it is this direct interest, vigorously fostered at all times and in all ways, that affords the striking example for those in other fields who, in this continued play of the forces of the new competition, so-called, would bring about the expansion which each desires. Yet, judging from the seeming indifference in some branches of industry, the lesson is not taken seriously, if indeed it has been learned.

Welding

Taken from Annual Report Research Committee, American Institute of Steel Construction

The research work of the committee with respect to welding has continued in the form of cooperation with the Structural Steel Welding Committee of the American Bureau of Welding organized about three years ago for the purpose of obtaining reliable information upon which safe unit working stresses in the designing of welded structures could be based. This work has been carried on in accordance with the program outlined in last year's report and at the present time the status of the work is as follows:

Qualification tests have been conducted at twenty-five shops where from one to three welders were qualified. The qualification of each welder required 20 tensile test coupons. Of the total of 1677 program specimens, more than one-third have been welded and shipped and most of these tested.

The necessary financing has now been completed by the following contributions:

American Institute of Steel Construction	$10,000.00
International Acetylene Association	5,021.68
National Electric Manufacturers Assn.	7,500.00
Total	$22,521.68

About $15,000 of the above amount has been spent for the printing of specifications, for qualifying the welders and for testing of the program specimens. Reports from the laboratories of material, testing qualification coupons and program specimens have accumulated to a point where it is desirable that work should be started on the arrangement and examination.

The full time services of an assistant for this work have been employed and it is believed that the work of the committee will be completed during the year 1930.

As a by-product of this program it is expected that some forty of the leading fabricating shops will be educated in the use of welding in their work and that universities will become familiar with the design of structural steel specimens and the strengths that may be expected from the various types of welds.

Nov. 8, 1929.

AUBREY WEYMOUTH, Post & McCord, New York, N. Y. (Chairman).

H. G. BALCOM, Consulting Engineer, New York, N. Y.

LEE H. MILLER (ex-officio), American Institute of Steel Construction, Inc., Cleveland, Ohio.

California Certified Boiler and Elevator Inspectors Meeting

The Ninth Annual Convention of the California Certified Boiler and Elevator Inspectors was held in Los Angeles on Jan. 14 to 18, 1930. The meetings were held under the auspices of the California Department of Industrial Relations, Division of Industrial Accidents in Safety. There were several papers on welding, including "The Question of Autogenous Welding," by Mr. C. E. McGinnes of the Board of Mechanical Engineers, Los Angeles, and Mr. C. W. Lieb. Mr. W. A. F. Millinger, chairman of the Los Angeles Section, presented a comprehensive review of welding progress, particularly in the pressure vessel and structural welding field. Keen interest was displayed in this paper and will probably form a basis of cooperation with these inspectors.

SECTION ACTIVITIES

Detroit

The January meeting of this Section was held at the Detroit Engineering Society Building Tuesday, Jan. 14, at 8.00 p.m. Prof. Frank P. McKibben, consulting engineer, gave an illustrated lecture on the "Welding of Steel Buildings and Bridges." There were present representatives from a number of the local sections of the Engineering Societies. The record attendance proved too large for the seating capacity of the auditorium. Mr. W. Spraragen, technical secretary of the American Welding Society, presented a brief review of some of the activities of the Society and its research department, the American Bureau of Welding. Considerable discussion followed the pre-

sentation of Professor McKibben's paper.

New York

The regular monthly meeting of the New York Section was held on Tuesday, Jan. 7. This was a joint meeting with the American Society of Mechanical Engineers. The subject of the meeting was "Fabrication of Machine Tools, Jigs and Fixtures." Two important papers dealing with this subject were presented as follows: "New Methods of Building Machine Tools, Jigs and Fixtures by Means of Arc Welding," by J. R. Weaver, Westinghouse Electric & Manufacturing Company, and "Cutting Steel Shapes with Mechanically Operated Torches," by F. E. Rogers, Air Reduction Sales Company. The meeting was well attended, and considerable discussion followed, indicating the keen interest in the possibilities of welding in the replacement of castings by welded steel parts.

Philadelphia

On Jan. 20 the Philadelphia Section held its monthly meeting. At 4.30 p.m. there was testing of welded specimens at the University of Pennsylvania; at 6.00 p.m., a dinner at the Engineers' Club, and at 8.00 p.m. the meeting in the main auditorium of the Engineers' Club. The paper of the evening was "More About Welding Steel Structures," by Frank P. McKibben, consulting engineer. The following took part in the discussion: H. L. Williams, McClintic-Marshall Co.; M. E. Hibbs, Bureau of Building Inspection; Prof. H. C. Berry, University of Pennsylvania, and J. B. Hendrickson of Mellon, Taylor, Hendrickson, Inc. Discussion and questions followed the regular program. About 350 people were present.

Western New York

The January meeting of this Section was held on the 13th. A paper on "Oxy-Acetylene Welding of Structural Steel" was presented by H. H. Moss of the Linde Air Products Company. His address was illustrated by moving pictures showing various stages of progress in the erection last year of the oxy-acetylene welded research building at the Niagara Falls plant of the Union Carbide Company and of other buildings.

EMPLOYMENT SERVICE BULLETIN

Opportunities.—The Society is glad to learn of desirable opportunities from responsible sources, announcements of which will be published without charge in the BULLETIN.

Services Available.—Under this heading brief announcements (not more than seventy-five words in length) will be published without charge to members. Announcements will not be repeated except upon request received after an interval of three months; during this period, names and records will remain in the office reference files.

Note.—Copy for publication in the BULLETIN should reach the Society's Office not later than the thirtieth of the month if publication in the following issue is desired. *ALL REPLIES should be addressed to the number indicated in each case and mailed to Society headquarters.*

SERVICES AVAILABLE

A-87. Engineer desires position. Two years' experience as welding engineer and plant engineer. Graduate Civil Engineering Course, University of California.

A-88. Welder desires position. Twelve years' experience in tank welding.

POSITIONS VACANT

V-46. Designers. Thoroughly experienced General Machine Designers, capable to design heavy machinery built of Cast Iron, Cast Steel or Welded Rolled Steel Shapes and Plates. Large firm, Eastern United States. Give education, experience, age and where employed. Your reply will be held confidential.

Welding on High Pressure Boilers

By Dipl. Ing. Fritz Hofmann†

THE building of modern boilers requires the adoption of all improvements and new developments in fabrication. The various processes of welding are particularly considered as one of the modern developments and are being used to a high degree in the building of high pressure boilers by the Loffler or Benson system. Fabrication by welding makes it possible not only to reduce the cost of construction, but also to simplify the construction. This latter fact results in an increase of its dependability in service.

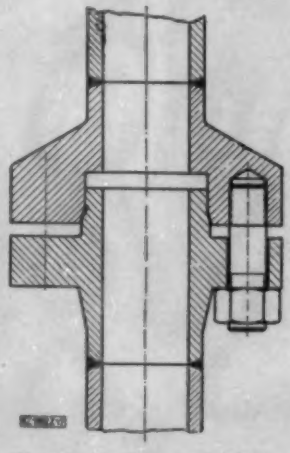


Fig. 1.—Location of Welds

In July, 1927, there was placed in operation in the steam electric power station of the "Karolina" plant of the Witkowitz Collieries, Czechoslovakia, a high pressure boiler of the Loffler type. This boiler has an output of 15 tons of steam per hour at a pressure of 1700 lb. and 930 deg. Fahr. superheating temperature. Maximum use of welding was made in the construction of this boiler. I propose to report the results after two years of operation. I take it that the design and the system of the Loffler high pressure boiler is known. However, reference is made to several publications.*

In the boiler erected at the above mentioned plant, not only are all the saturated and superheated steam pipe lines made of seamless tubes connected by butt welding, but, also, the superheater and the economizer

*Mechanical Engineering, April, 1927—Zeitschrift des Vereines deutscher Ingenieure (Journal of the Association of German Engineers) Vol. 72 (1928) Nos. 39, 42 and 45.

†Diplom Ingenieur, Witkowitz-Eisenwerk.

are made of single coils connected to each other by oxy-acetylene welding. Throughout the following discussion, welding will be assumed to refer to the oxy-acetylene process.

Flange joints are being used only on steam drums, dryer drums, circulation pumps and fittings. All other joints are made by the welding processes. The tube ends are beveled at an angle of 30-45 deg., depending on the thickness and diameter of the tubes. The weld metal is deposited in the V-shaped groove between the tube ends. (See Fig. 1.) In Fig. 2 are shown the flanges on the steam dryer to which are to be welded the steam pipe lines. The beveling is clearly indi-

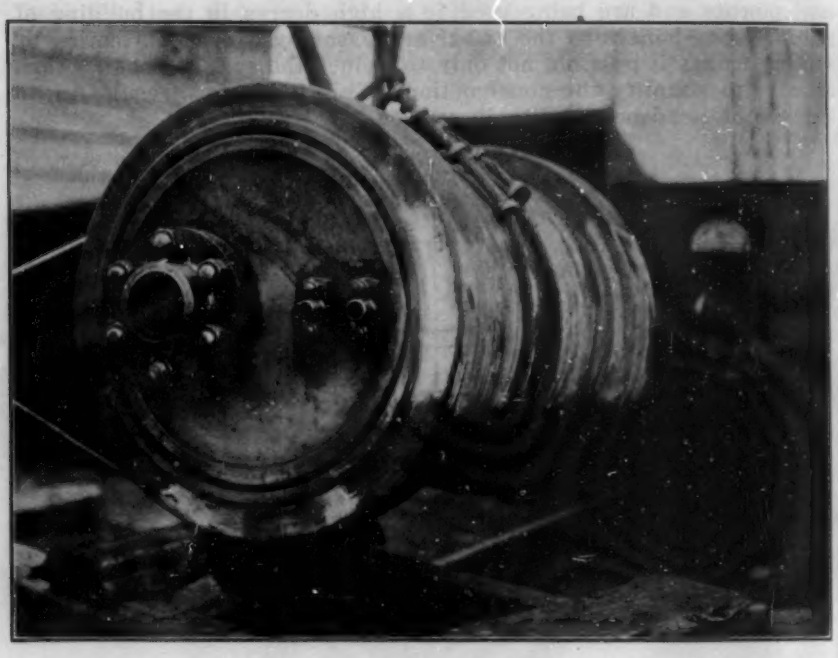


FIG. 2.—STEAM DRYER

cated. The U-shaped tubes (diameter 1¾ in. to 2½ in.) of the radiation superheater which are placed in the combustion chamber which is fired by pulverized coal at a temperature up to 2730 deg. Fahr., are welded to the tubular collectors. (See Figs. 3, 4 and 5). Fig. 6 shows how the coils of the second superheater are made; the single coils are welded to each other at the sections which are not curved and the welded joints may be recognized by the swelled parts.

Before proceeding with welding work, the beveled and carefully cleaned tube ends are tightly fitted together in order to prevent welding-through, which would result in a reduction of the inside diameter of the tubes. It is necessary to heat the welding seam with the welding torch before adding the filler material in order to obtain a thorough fusion of the filler material with the tube and not merely adher-

ence to the tube. Right after the welding the welded seam is hammered with a small hammer until the red heat disappears. This removes any slag, on the one hand, and refines the grain on the other hand. Of course, the welding must not be done with an oxidizing flame. It is also necessary to anneal the welded seam. The annealing temperature depends upon the quality of material. In the factory this is done in the annealing furnace, whereas, on the place of erection of boiler, annealing is done by the welding torch in order to normalize the texture both of welding material and the tube. It seems, however, that this principle is often neglected and in many cases failure is the result of such neglect.

FIG. 3.

In the following is shown that above stated operations are necessary in order to insure careful welding.

Figs. 7, 8 and 9 show etched sections of welded seams of a seamless high pressure tube 3 in. 2/¼ in. diameter, made of pure carbon steel, containing 0.32 per cent C. of 78,000-92,500 lb. per square inch tensile strength with 18-15 per cent elongation; welding is done by oxy-acetylene method with the same material. This tube intended for the second superheater carries steam of 1700 lb. per square inch and 930 deg. Fahr. superheat; its welded seam is exposed to the flue gas, having a temperature of 1830-2190 deg. Fahr.

Fig. 7 shows the welding work before any subsequent treatment after welding.

In Fig. 8 the welded seam has been hammered.

In Fig. 9 the welded seam has been hammered and annealed.

Fig. 10 shows another kind of welding which will be dealt with later on.

The metallographic researches referring to above figures are shown alongside.

Although the etched macrograph of welded seams of the Figs. 7 and 8 show good fusion between tube and welding material, the material of the tube is much overheated because of the welding heat and has an extremely coarse grain. This is confirmed by micro-metallographic researches. For comparison there is shown a micro-photo of the tex-

FIG. 4.—WELDED TUBES

ture of the tube material, not having been affected by the welding (see Fig. 13) showing fine grained Ferrite and Perlite. On the other hand, Figs. 7a, 7b, 8a and 8b, show alongside the welded seam a coarse grain and needle-shaped Ferrite resulting from the overheating of the material. It is remarkable that the photos 8a and b begin to show a reduced grain, which may be explained by hammering. Figs. 9a and b show a very fine grain according to the correct kind of welding, i.e., the welding with subsequent treatment. These figures also show equalization of the carbon contents between the tube and the welding material.

It is a fact that the above mentioned overheating does not always occur and can be considered as a complication which can be easily avoided. This can be seen from Figs. 11 and 12, showing macrographs

of etched welded sections, ordinarily made, hammered but not annealed. There must not be coarse grain nor any overheated texture. As it is not always possible to examine the texture of welding, however, faults may result from the heat treatment. Therefore, it is desirable to have high-pressure welded boilers annealed.

In addition to the beforementioned metallographic researches, there are given in Table I the tensile tests, which are in conformity with the metallographic researches.

FIG. 5.—WELDED TUBES

TABLE I

Test No. (Corresponding with Photo No.)	68° F.			1020° F.		
	Tensile, Lb./Sq. In.	Yield Point, Lb./Sq. In.	Elong. %	Test Length, In.	Tensile, Lb./Sq. In.	Yield Point, Lb./Sq. In.
7	57,040	49,080	1.1	5.5	19,060	9,100
8	56,760	54,480	1.4	5.6	31,440	20,910
9	68,420	46,650	7.3	6.0	34,140	21,620
10	81,220	47,370	7.9	5.9	40,540	29,300

Note: The tests were taken from the tubes, by planing and machining all over; by this way the effect of the increased cross section resulting from welding is eliminated.

After the boiler in the Karolina plant had been in operation about 5000 hours, there were cut out those parts of the superheater and economizer tubes with welding which had been exposed to the severest demands. These tubes had to stand besides the inside pressure of 1700

lb., a steam temperature of 590-750 deg. Fahr. at a flue gas temperature up to 2730 deg. Fahr. on the radiation superheater and a steam temperature of 900-970 deg. Fahr. at a flue gas temperature up to 2190 deg. Fahr. on the second superheater. These tubes and welding work were tested again and it was found that the texture and the tensile tests, compared with the tests made before starting of the boiler, did not show any adverse change in material (see Table II). Tensile tests at 1020 deg. Fahr.:

TABLE II

	Material Before Starting	Material After 5000 H. of Service		
		Test No. 1	Test No. 2	Test No. 3
Yield point, lb./sq. in.	20,480	19,350	16,930	23,610
Tensile, lb./sq. in.	33,570	41,250	30,010	33,280

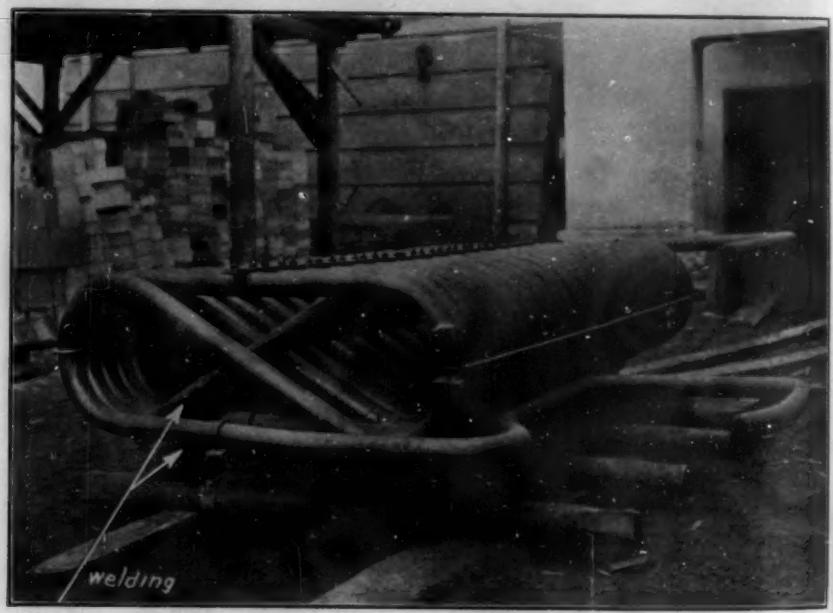


FIG. 6.—COILS OF THE SECOND SUPERHEATER

The tensile tests have been made at 1020 deg. Fahr., because this temperature corresponds with the average temperature of tube and welds, in case of tubes exposed to the severest conditions.

On this occasion it must be mentioned that even today after 10,000 hours of service all of the many hundred of welds have proved to be intact without causing the slightest trouble.

Having up to now considered only oxy-acetylene welding, I should like to make some observations on electric welding.

Arc welding cannot be considered at boiler construction, working at

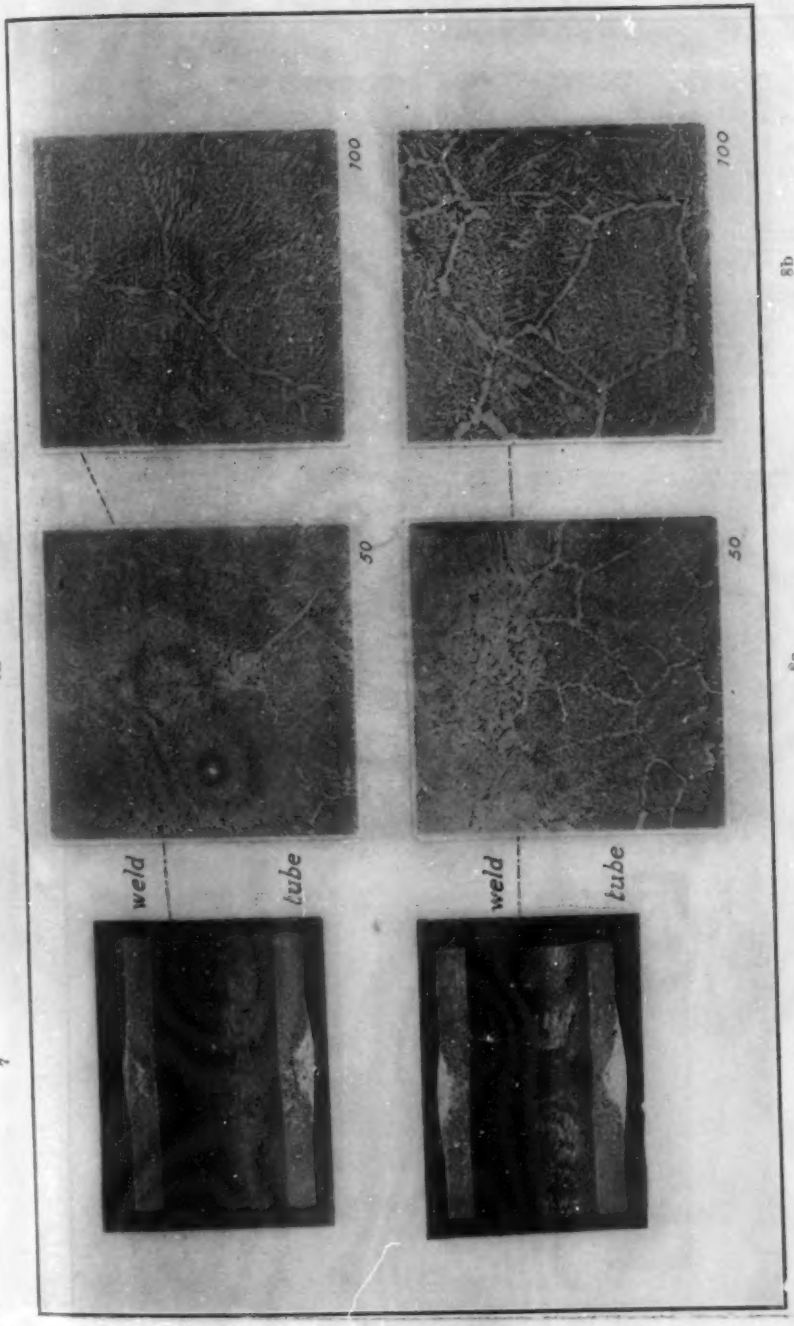


FIG. 7.—(UPPER) SHOWS THE WELDING WORK BEFORE ANY SUBSEQUENT TREATMENT AFTER WELDING

FIG. 8.—(LOWER) WELDED SEAM HAS BEEN HAMMERED

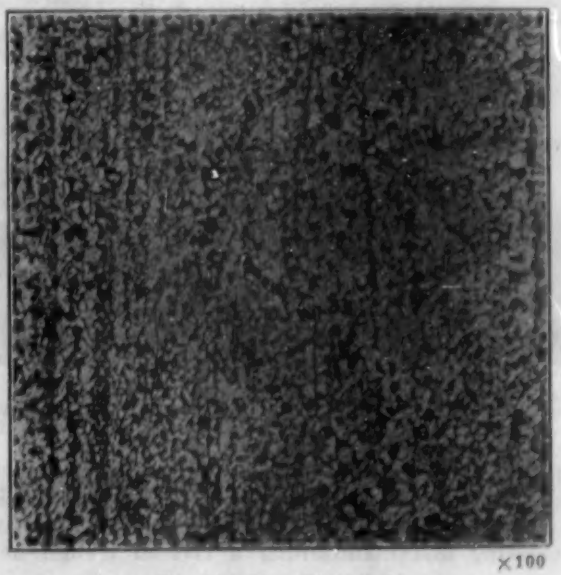
FIG. 9.—(UPPER) WELDED SEAM HAS BEEN HAMMERED AND ANNEALED
FIG. 10.—(LOWER) RESISTANCE WELDED TUBE

temperatures of 930 deg. Fahr. and more. This kind of welding includes besides the already known circumstances some danger, I will speak of in the following paragraphs.

Most arc welding is done with protected welding rod. The jacket around the welding rod consists partly of charcoal or carbon containing mixtures. At the temperature existing in the arc there occurs a diffusion of the carbon into the tube material, if it is hard steel, i.e., having 85,400 lb./sq. in. tensile strength with 0.32 per cent C.

This causes an increase of carbon. It is possible to raise the carbon

FIG. 11 AND 12.—ETCHED SECTIONS HAMMERED, BUT NOT ANNEALED



×100

FIG. 13.—TUBE MATERIAL

FIG. 9.—(UPPER) WELDED SEAM HAS BEEN HAMMERED AND ANNEALED
FIG. 10.—(LOWER) RESISTANCE WELDED TUBE

content from 0.3 per cent C. to 0.8 per cent.; this increase of carbon occurs up to a depth of nearly a quarter-inch.

On the other hand, the test pieces of the tubes, welded by "flash" resistance welding, have shown the best results of all. Welding made by this system shows 100 per cent of the tensile strength of the tube material. Fig. 10 shows the etched view of such welding, which has been done with the same material as before (pure C-steel of 78,000-92,500 lb./sq. in. tensile strength). (See Figs. 7, 8 and 9.) The welding seam is hardly to be recognized in the macro etching but the microphotos 10a and b show the boundary as a light stripe, slightly decarburized. The material next to the welding seam has overheated texture, but without perceptible increasing of grain growth. The tensile researches, as shown in Table I in the comparison with the tests 7, 8 and 9, are very interesting and show the excellent quality of this kind of welding. These results obtained by flash resistance welding have been confirmed by numerous tests and it is to be expected that this kind of welding will probably be preferred on a large scale.

At any rate, all tests have proved that correct welding is a dependable element of construction in the building of high pressure boilers. Of course, it requires, as is the case with every product, a dependable and skillful production.

Bridges Welded in Field on Australian Railway

EXTENSIVE use was made of field welding in the erection of railway bridges and underpasses on an extension to an electrified railway system running out of Melbourne, Victoria, Australia, according to the "Commonwealth Engineer."

FIG. 1.—WELDED DECK AND GUSSETS, MAIN SPAN OVER SCOTCHMAN'S CREEK

FIG. 2.—SHORTER SPANS OVER SCOTCHMAN'S CREEK, SHOWING WELDED BRACING AND REFUGE BAY

The main span of the bridge carrying the road over Scotchman's Creek is a steel through plate girder with a span of 48 ft. 9 in. Limited headroom made necessary as shallow a deck as possible. To avoid the difficulties of erecting and maintaining a riveted trough deck, a welded

*Reprinted from December issue, *Engineering & Contracting.*

trough deck was adopted. The deck is composed of 15 x 4-in. channels, alternating with flanges up and flanges down, and having the toes of the flanges welded together. The ends of the channels were welded direct to the girder webs without any shelf angles, etc.; thus no surfaces were left in contact where corrosion might take place. The sections were cut to fit at the site and welded in the field. The gussets were also welded to the girder webs and the deck. It is stated that the welded deck cost about three-fifths of the cost of a riveted deck, no account being taken of the saving in avoiding erection in the shop.

FIG. 3.—BRIDGE AT WARRIGAL ROAD, SHOWING WELDED DECK, GUSSETS AND END STIFFENERS

FIG. 4.—WELDED SUBSTRUCTURE OF ONE OF THE HIGHWAY CROSSINGS

The remainder of the bridge consists of deck spans 26 ft. 6 in. in length. Each rail is carried on two 24-in. I-beams. One of the illustrations shows this construction as well as the angle bracing, which was sent to the site in random lengths, cut to fit and welded. The picture also shows a welded refuge bay.

Welding was also used to a large extent in the erection of the highway bridges eliminating grade crossings along the line. As shown in one of the illustrations, the transverse I-beams carrying the deck were welded to the steel columns, as was the bracing. In erecting these bridges, the decking was first erected on temporary trestles. Following this, the columns were welded to the transverse beams and the concrete pedestals were poured around the feet of the columns. This did away with the necessity for machining the columns to exact length.

Report of Tests Made Upon Welded Joints for Boston Section of the American Welding Society

IN connection with the Structural Steel Cutting and Welding program held by the Boston Section of the American Welding Society, under the auspices of the Engineering Societies of Boston, a series of 15 joints were welded at the Massachusetts Institute of Technology, Cambridge, Mass., Oct. 10, 1929, in accordance with specifications shown in the program of the meeting held at the Institute on that date.

These specimens were prepared by three companies, to be designated as A, W and G. The specification for each type of specimen, together with the prediction of location of failure, were shown on the program. A sketch of each type of specimen, results of tests, together with a description of the location of failure, is reproduced herewith.

Tests:

The tests were made in the Testing Materials Laboratory of the Massachusetts Institute of Technology by Prof. H. W. Hayward.

The machine used was a Riehle three-screw universal of 400,000 lb. capacity. Load was applied up to about one-half strength at the rate of 0.4 in. per minute, and after that at the rate of 0.1 in. per minute to fracture.

Test Results:

Specimen 1—Location of failure; fracture of all welds in shear.

Specimen No.	Max. Load, Lb.
A-1	261,900
W-1	348,200
G-1	299,400

Specimen 2—Location of failure; fracture of all welds in shear.

Specimen No.	Max. Load, Lb.
A-2	184,300
W-2	222,800
G-2	220,800

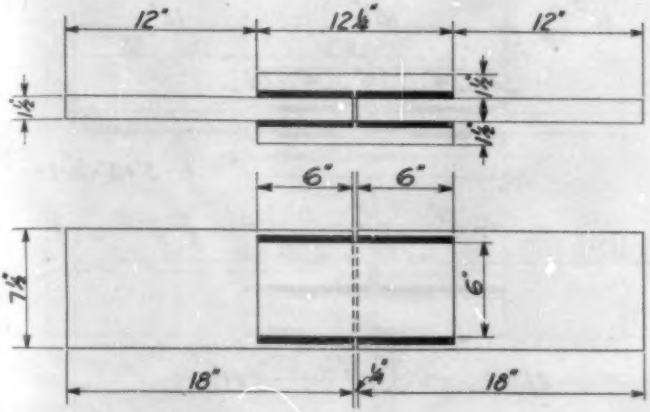
Specimen 3—Location of failure; fracture of both angles in tension.

Specimen No.	Max. Load, Lb.
A-3	225,400
W-3	231,700
G-3	228,400

Specimen 4—Location of failure; fracture of both channels in tension.

Specimen No.	Max. Load, Lb.
A-4	276,200
W-4	282,600
G-4	268,300

1.

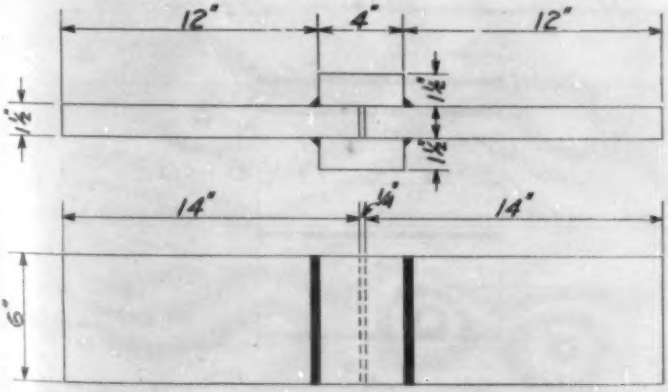


PARALLEL SHEAR.

⅜" BEAD.

MINIMUM PLATE AREA	7½" × 1½" = 11.250 □"
MINIMUM WELD AREA	⌐ 24" × ⅜" × .707 = 6.360 □"
LINEAR INCHES ⅜" WELD	24"

2.

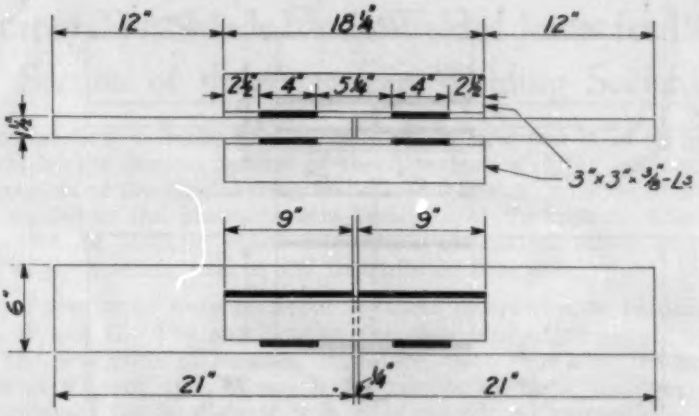


NORMAL SHEAR.

⅜" BEAD

MINIMUM PLATE AREA	6" × 1½" = 9.000 □"
MINIMUM WELD AREA	⌐ 12" × ⅜" × .707 = 3.180 □"
LINEAR INCHES ⅜" WELD	12"

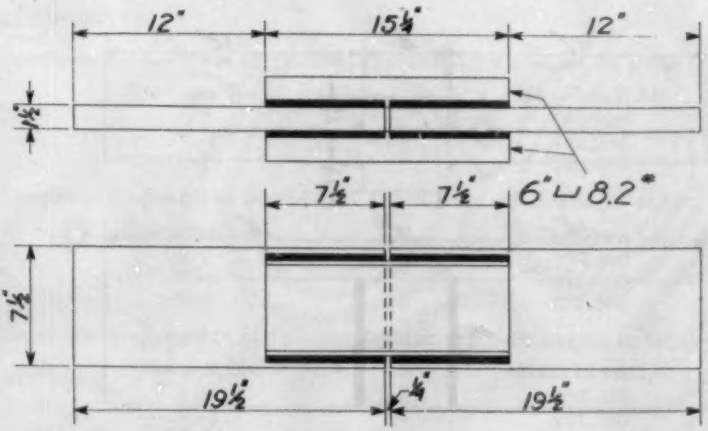
3.



PARALLEL SHEAR. ⅜" BEAD.

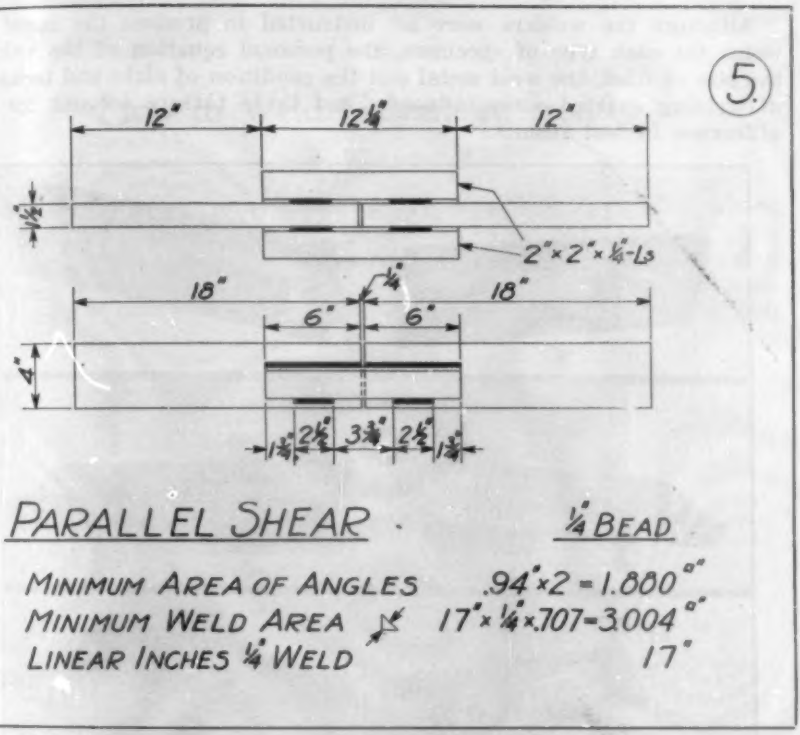
MINIMUM AREA OF ANGLES 2.11×2 = 4.220 □"
MINIMUM WELD AREA ⊿ 26"×⅜"×.707 = 6.893 □"
LINEAR INCHES ⅜" WELD 26"

4.



PARALLEL SHEAR. ⅜" BEAD

MINIMUM AREA OF CHANNELS 2.39×2 = 4.780 □"
MINIMUM WELD AREA ⊿ 30"×⅜"×.707 = 7.954 □"
LINEAR INCHES ⅜" WELD 30"



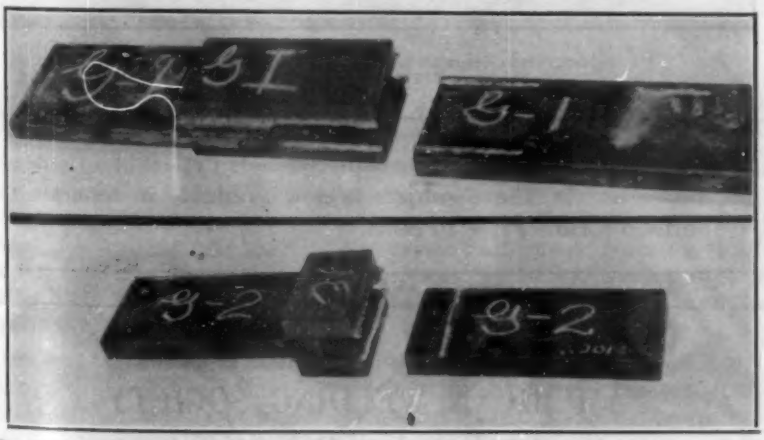


FIG. 6.—PHOTOGRAPHS SHOWING TYPICAL FAILURE OF SPECIMENS OF TYPE 1 AND 2

Specimen 5—Location of failure; fracture of both angles in tension.

Specimen No.	Max. Load, Lb.
A-5	110,100
W-5	109,400
G-5	108,400

Although the welders were all instructed to produce the same size welds for each type of specimen, the personal equation of the welders, the size of fillet, the weld metal and the condition of plate and technique of welding exerted some influence, and these factors account for any difference in test results.

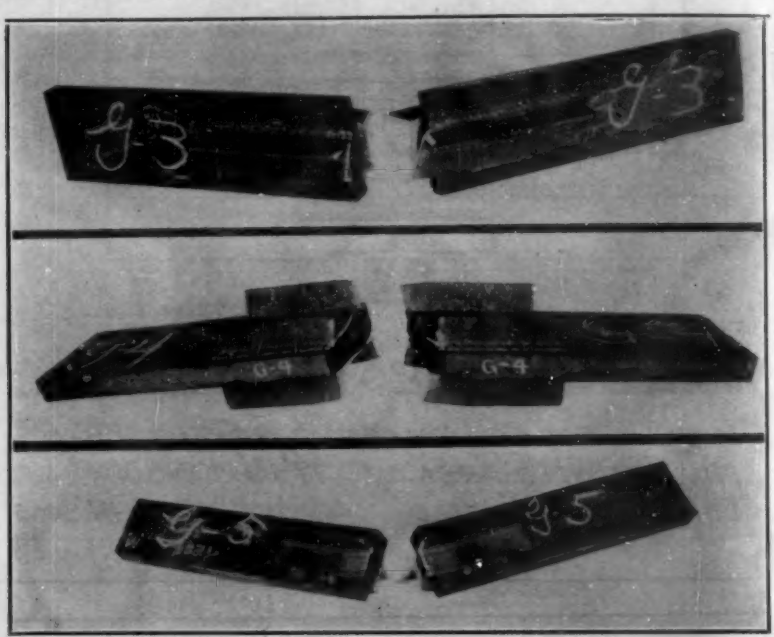


FIG. 7.—PHOTOGRAPHS SHOWING TYPICAL FRACTURES OF SPECIMENS OF TYPE 3, 4 AND 5

Nomenclature, Definitions and Symbols Report of a Committee on the above subject is now available in separate bulletin form. Price 50 cents.

Annual Meeting

AMERICAN WELDING SOCIETY

New York, April 23, 24 and 25

Annual Dinner

Thursday, April 24, 1930

How to Weld Galvanized Iron†

A. G. WIKOFF*

GALVANIZED iron is used extensively for service conditions where uncoated iron or steel would be subject to serious corrosion. The coating of zinc which forms the galvanizing is applied by immersing the iron base material, whether sheet, pipe or other form, in molten zinc. A layer of flux on the surface of the zinc bath cleans the iron

FIG. 1.—FIELD WELDS

as it is introduced and insures a firmly adherent coating of zinc on the galvanized material. This process is known as hot-dip galvanizing.

Zinc has a relatively low melting point and also has the property of volatilizing when heated. Consequently, when galvanized material is heated the zinc coating does not melt and run on the surface, as might be expected, but instead the zinc vaporizes and burns, forming the familiar white fumes of zinc oxide. The welding of galvanized material results in the loss of a certain amount of zinc coating from the surface immediately adjacent to the weld.

Some welded products such as coils can be completely welded prior to the galvanizing operation. In such cases, of course, the problem of welding galvanized material does not enter as all of the welds are made in steel before coating with zinc.

For the welding of galvanized material either steel or bronze welding rod may be used. Welding with steel rod requires a higher temperature and thus removes more of the galvanized coating. This method

*Technical Publicity, The Linde Air Products Company.

is frequently used, however, where the welded part can be given a coat of protective paint after welding is completed. For most applications bronze welding is to be recommended, as the relatively low temperature has less effect on the galvanized coating.

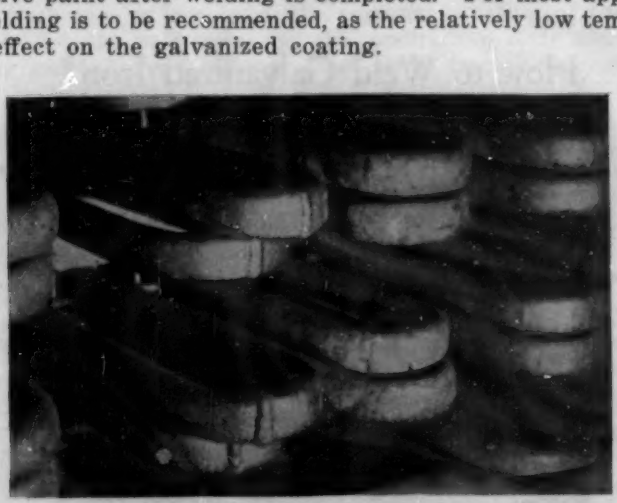


FIG. 2.—AFTER PAINTING

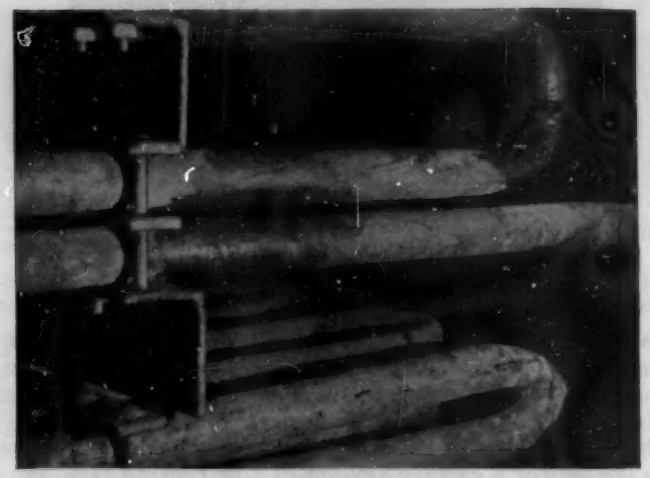


FIG. 3.—FIELD WELD ABOVE, SHOP WELD BELOW

Welding Galvanized Iron with Steel Welding Rod

One large manufacturer of carbon dioxide refrigeration systems has standardized on the use of steel welding rod for making field welds in galvanized coils used in air conditioning systems. Many installations have been made in office buildings and theaters. The coils are fabricated in sections at the shop, the shop welds being made before the section is galvanized. During installation the galvanized sections are welded together, using a high strength steel welding rod. Fig. 1

shows a group of the field welds just after completion. The welds are later finished with a coat of aluminum paint, Fig. 2. Shop weld and field weld are contrasted in Fig. 3, the more abrupt bend being the shop made one.

No corrosion difficulties have been experienced due to possible loss of zinc coating from the inside of the pipe during welding. In this connection, it should be remembered that the cutting and threading of galvanized pipe also removes a certain amount of the protective zinc

FIG. 4.—GALVANIZED PIPE BEVELED WITH BLOWPIPE

FIG. 5.—BRONZE WELDING GALVANIZED WATER LINE

coating. Experience seems to indicate that the welded joint in galvanized pipe is at least as good as the screw-coupled joint so far as internal corrosion is concerned.

Bronze-Welded Galvanized Iron Pipe

Bronze-welding has been found very effective for the installation of galvanized piping for water and other industrial services. The installation is made in exactly the same manner as a steel line. Pipe can be cut and beveled with the cutting blowpipe without serious injury to the galvanized coating, Fig. 4. It is then lined up, tack-welded and welded in accordance with the usual procedure for bronze welding. The recently developed high strength bronze rod is particularly recommended for bronze-welding galvanized iron. The completed weld presents a very attractive appearance and in practically all cases no coating of paint or other protective material need be applied. Fig. 5 shows the installation of a bronze-welded 6-in. galvanized water line.

Bronze-Welding Galvanized Sheet

Bronze-welding is also extensively employed in the fabrication of

various articles from galvanized sheet. Many types of storage tanks and containers are made in this way.

The advantages of bronze-welded construction are well illustrated in the case of the gas bell of a widely used acetylene generator designed for household lighting systems.

Until recently the gas bell of this type generator was made of 20-gage galvanized sheet steel. Vertical seam was of single-lock seam construction with solder sweated into the seam. The bell-top to bell-

FIG. 6.—JIG FOR SIDE SEAM

FIG. 7.—RAPIDLY WELDED WITH BRONZE

body seam was of double-lock seam construction with solder sweated into the seam. With this type of construction, thickness of the sheet metal used was limited to 20 gage because of the difficulty in double-lock seaming heavier gage material. It was also found that the seams would develop leaks if handled roughly during shipment or in service.

To make the gas bell more substantial by increasing the thickness of the metal used to 18 gage and to provide a method of manufacture that would insure the seams remaining tight, even though subjected to rough handling in transit or in service, it was decided to change to bronze-welded construction. The results have been all that could be desired. Previous to the adoption of bronze welding, careful inspection of gas bells that were returned to the factory showed that 24 per cent had developed slight seam leaks. No leaks were found in any bronze welded gas bells returned during a like period of four months. This record is the best kind of proof of the merits of bronze-welded construction. Tests made on a Riehle physical testing machine show the bronze welded seams to be 315 per cent stronger than the soldered double-lock seams.

Several ingenious jigs were developed to facilitate the fabrication of the bronze-welded gas bells. Fig. 6 shows the jig used in welding the vertical seam of the gas bell. This fixture consists mainly of a pair of welded arms which, when clamped into position, hold the sheet metal in such a way as to prevent all buckling and creeping. Copper inserts built into the fixture stakes assist in conducting heat rapidly away from the welding zone. Fig. 7 shows the vertical seam weld being made in this jig.

FIG. 8.—FOR HOLDING HEAD IN CORRECT POSITION

For holding the gas bell head or top in correct alignment with the shell the jig in Fig. 8 is used.

In addition, replacing a flanged fitting on the generator neck by a standard pipe nipple bronze-welded in place has materially increased strength, decreased the possibility of leaks and reduced cost.

Welding in the Metal Furniture Industry

A. F. DAVIS†

THE art of making attractive furniture is passing from the hands of the traditional wood worker to the oxy-acetylene welder as the public demand for articles fabricated of sheet metal continues to grow. There are at the present in the United States hundreds of firms engaged in the manufacture of metal furniture. These vary in size from the large producers of file cabinets, library, bedroom and hospital furniture to the smaller concerns which execute only a few orders.

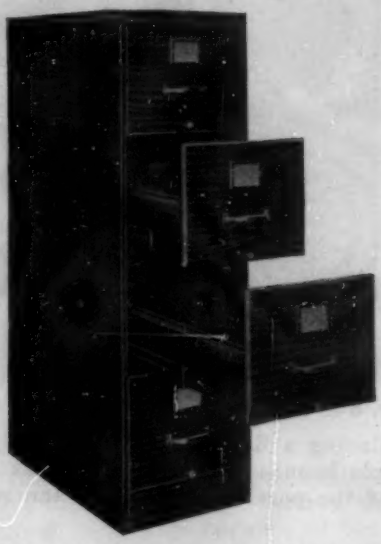


FIG. 1—THE PIONEER IN WELDED SHEET METAL FURNITURE

Although it is still a comparative novelty, metal furniture is becoming more and more acceptable for general service, as may be seen from the variety of welded sheet metal articles now on the market. Among the standard items of furniture now being made are office files, letter cabinets, desks, tables, chairs, beds, dressers, trunk chairs, medicine chests, safes, hospital equipment, cribs, lockers, cots, and wheeled tables and chairs. It may be seen from the above partial list that there are few objects in the home, hospital, hotel, office, or institution which cannot be made from sheet metal with the aid of welding. Wherever heavy service is required, as in hotels and public buildings, such objects are indispensable, as losses from furniture breakage are eliminated.

†Linde Air Products Co.

The steel office file was the pioneer in the welded metal furniture field. This is one of the most important items of office equipment and must be designed primarily for strength to resist the shock of having the drawers opened and slammed shut hundreds of times a day. The welded seam is not only the best type of joint to withstand this constant impact but it also insures corners free from sharp edges.

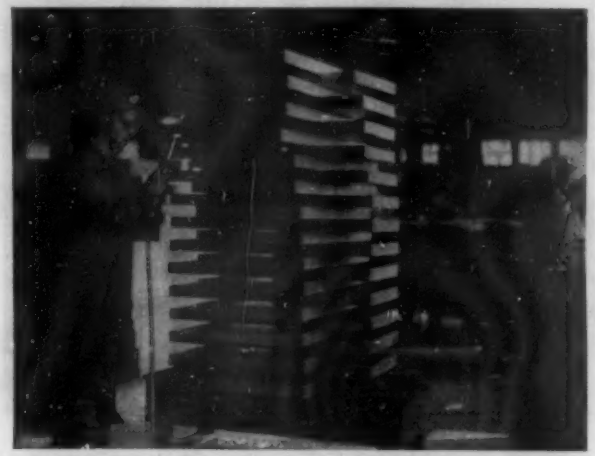


FIG. 2—A SPEEDY WAY OF WELDING CORNER SEAMS

FIG. 3—FILE FRAMES LINED UP FOR ASSEMBLY BY WELDING

A firm engaged in the manufacture of these files as well as other metal office furniture has been stepping up production to take care of the extraordinary demand occasioned near the end of the year by the changing of files in nearly every office in the country. Fig. 2 shows one of the plant welders at work with a sheet metal welding blow-pipe joining the corner seams of the tops for the cabinets. It will be noted that there are

about 27 of these tops piled alternately at right angles, one on top of the other, so that the welder can go up and down the pile, welding the corners with great speed. Fig. 3 shows the outer frames of the cabinet lined up in rows while a welder completes the assembly by welding up the back seams.

FIG. 4—JIG HOLDS DRESSER IN POSITION FOR WELDER

FIG. 5—FOOT FRAME OF METAL BED AFTER JOINTS HAVE BEEN WELDED

It may be noted from this photograph, Fig. 3, that the tops have already been joined to the sides by means of oxy-acetylene welding. The smooth corners at all the joints make the steel surface suitable for a coat of lacquer. Fig. 1 shows one of these standard welded steel filing cabinets in its completed form with a "mahogany" finish. The joints on this cabinet were welded with steel rod to withstand enameling.

The question naturally arose in the metal industry of why, if office

files were built of metal for strength, should not other items of furniture be built the same way. In the early stages of the metal furniture industry the essential difficulty experienced was that of appearance. It was a problem at first to devise a joint for steel parts which was comparable in its neatness to that of glued wood joints. Rivets, bolted seams, and screw threads all lacked the quality of wooden furniture. Within the last ten years, the universal adoption of the oxy-acetylene process by the metal industry has completely eliminated any problems in joining. Practically all the technique of metal furniture making lies in welding sheet and tubing forms. Shaping and fitting the tubular members is very important, as in many cases the tubes must be put through several processes before being ready for assembly. Slight errors in dimensions multiply rapidly.

FIG. 6—WELDED CHAIRS IN ASSEMBLY DEPARTMENT

In laying out work, all parts are planned to permit the least stamping and cutting losses. Often smaller pieces are made from left over material. In this respect, the metal furniture builder can practically eliminate waste, whereas the waste of material in wooden furniture fabrication is enormous. In most articles of furniture, light steel sheet is used, which, when formed into a cross section, has the utmost strength and weighs slightly less than wood. This has been most logically demonstrated in the replacement of wood trusses in air-craft by welded steel tubing. Seamless tubing shapes have been devised to take almost any design formulæ available in wood. These are tangent-joined to plates, which assures a production method involving low costs.

The assembly of furniture, involving the alignment of a number of parallel and angular pieces, is usually performed by means of a jig which keeps all the elements lined in position. These are often very involved, to permit rapid welding and efficient handling. The weight of the assembly and the ease of misaligning the parts makes the use of a proper jig important. Fig. 4 shows a rather complicated jig which is being used in the assembly by welding of a metal dresser. A jig of this type is very nearly fool proof, as it grips the article being welded in so many

places that a misalignment of parts is an impossibility. In production work on metal furniture, it is usually necessary to design such a jig for each type of assembly being welded.

Another great asset of the oxy-acetylene welded joint is that it is the only metal joint which successfully "takes" the enamel. Steel welding rod must be used when this type of finish is to be employed as it is the only rod capable of withstanding enamelling temperatures. Where other types of finish are used, bronze-welding is more often employed. The reason for this is that bronze-welded rod melts at a low temperature, and it is unnecessary to bring the parts being joined to the melting point. This results in economies in gases and speedier production work.

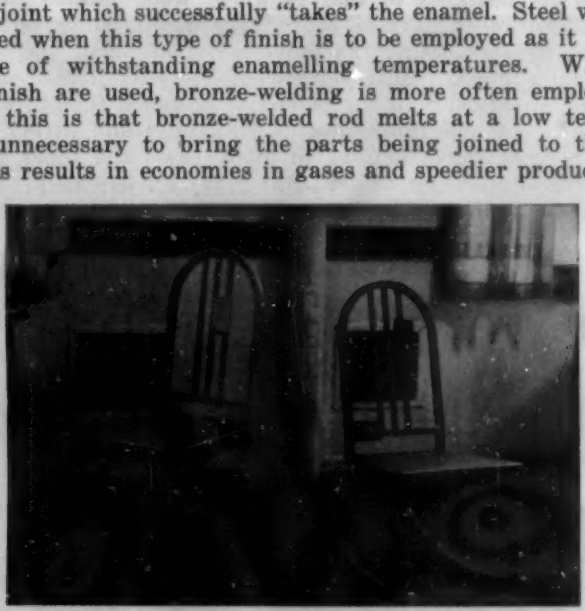


FIG. 7.—METAL BEDROOM CHAIRS PRESENT A NEAT APPEARANCE

In the field of metal furniture for the home, the most universal article is the all welded sheet metal bed. For durability, neatness of appearance, and cleanliness, this type of bed has taken the lead. Fig. 5 shows the foot frame of one of these beds after the welding has been completed. The head and foot frames of these beds are made of sheet steel tubing of various shapes and artistic design. All the joints of this tubing are welded with steel welding rod at the mitered corners. The more elaborate designs of beds require a greater number of mitered joints. After welding has been completed, the joints are ground to a true surface, making it impossible to detect the weld from the original metal. Some of the more expensive models of beds are constructed using panels of perforated steel to resemble cane panels. Intricately designed head and foot frames, including these imitation cane perforated steel panels, are equal in appearance to well built wooden beds and possess many times the strength.

A prominent concern engaged in the manufacture of sheet metal beds was so successful in producing various artistically designed types of beds that about four years ago they expanded their business to include the fabrication of tables, chairs, dressers and, in fact, all items of bedroom furniture. In this broader field they have met with equal success. Fig 6 shows a number of all welded chairs in the final stages of assembly.

Two bedroom chairs assembled and enameled may be seen in Fig. 7. A bedroom suite of furniture is shown in Fig. 8. All the refinement of tasteful wooden furniture has been obtained in metal in addition to the unequalled durability of welded metal construction.

This material used in the construction of this furniture consists of cold rolled strip stock and cold finished sheets. The frame work is entirely made from seamless tubing, produced in the company's own mills. Some designs of legs and mirror posts are formed tubing which is swaged to a graceful taper in swaging machines. The dresser shown in Fig. 8 provides a good example, as it requires 280 separate operations during its fabrication before it is ready to have the finish applied. Many of these operations are performed by the plant's punching presses. When

FIG. 8—A MODEL BEDROOM WITH ALL METAL FURNITURE

the various parts have been formed, they are then welded together. The forming of the drawer frame is one of the first operations in the fabrication of this dresser. This is the main frame of the dresser and is made of tubing cut to the proper length, fitted together in the jig shown in Fig. 4 and the joints bronze-welded with the oxy-acetylene blowpipe. The bottom frame is similarly assembled upon a jig and welded to the frame members. The corner posts are fitted to the bottom and drawer frames and bronze-welded in a jig. The sheet metal top is also bronze-welded to the frame at each corner. The mirror frames are made with mitered oxy-acetylene welded corners.

There exists today a very large market for the manufacturer, such as the one just mentioned, who can secure economical large scale production with the refinements of individual design. Metal furniture must have a treatment which expresses its own inner quality and not be entirely dependent upon imitations of wood for its design. With the use of oxy-acetylene welding, the opportunities for working out new ideas are unlimited.

Welding of Galvanized Sheets

Question:

What are your recommendations as to the best way of welding galvanized sheets?

Answers:

H. A. Woofter, Chief Engineer, Swift Electric Welder Company. By the resistance process, galvanized stock of any kind usually welds as nicely or nicer than ungalvanized stock for the reason that it is not rusty and gives a good electrical contact in the dies. Galvanized pipe, angles, rods, bars or various shaped sections weld very nicely when galvanized. However, paint or shellac or Duco on top of the galvanizing is detrimental since it affects the electrical contact between the work and the dies. Galvanized sheets can also be welded very nicely by the resistance seam method. In spot welding galvanized stock, it is desirable if not absolutely necessary that the die points should be somewhat oval instead of flat so that the current will go through the center first and thus drive off the zinc in small ripples like ripples on water when a stone is thrown in. This leaves the clean steel for the spot weld of the stock. One objection to the welding of galvanized stock by any welding process I know of is that it volatilizes the zinc from the immediate neighborhood of the weld, leaving a bare iron strip that will rust. If, however, the galvanized stock is to be painted before it is installed or soon after, there is no harmful effect, but when large galvanized pipe is welded together and buried under the earth, the strip or band about ½ in. or ¾ in. wide on the pipes from which the zinc has been volatilized, will rust. Also in spot welded galvanized culverts, the spots will show rust after some months of use unless they have been painted.

H. H. Moss, Development Section-Engineering Department, Linde Air Products Company. There is published elsewhere in this issue an article on the oxy-acetylene welding of galvanized piping and galvanized sheet iron. It has been my experience that galvanized iron and galvanized piping can be successfully welded if a little care is exercised in preparing the joints and in selecting the proper size welding flame and welding rod. It has been our practice to use high test rod where fusion welding of this kind of material is called for. On the other hand, we resort to bronze welding wherever the bronze weld will not interfere or be affected by the substances contained in the article being welded. The welder should use a very small flame so as not to heat the metal around the joint beyond that required to obtain good fusion. The zinc along a narrow margin bordering the weld will be completely volatilized if fusion welding is used exposing the base metal, and which is usually coated with some preservative, as explained

in the above article. Where bronze is used the volatilization is not complete, leaving some spelter after the bronze has solidified. In constructing galvanized piping in the field, the cutting and threading operations expose base or ungalvanized metal and several of the contractors with whom we have been working, claim that they see no difference in the result obtained in fusion welding as compared to what they obtained in field fabrication of galvanized piping.

If the welding is carefully done and a 20 per cent reinforcement is provided, the thickness of the material at the joint should withstand the action of corrosion as well as the galvanized surfaces away from the joint. Slight discoloration within the piping system so welded has apparently not been severe enough to disqualify this method of welding. It is recommended that the zinc coating along the edge of the joint be removed for about ⅛ in. by a file so as to prevent the inclusion of metal if care is not exercised by the operator to prevent the zinc from running into the molten puddle. Usually the operator is enabled to volatilize the zinc coating about the edge of the joint ahead of the deposition operation. For ordinary services and medium pressures, the results have been very satisfactory when these general precautions have been taken.

Alexander Churchward, Consulting Engineer, Wilson Welder & Metals Co. We would always clean the surface before welding if any oil showed on the surface. In regard to arc welding galvanized sheets, no trouble will be encountered if the current and size of electrode is kept small.

Addition to Lincoln Plant Entirely Arc Welded

C. M. TAYLOR*

THE rapid momentum which has been gained in the construction of steel framework for buildings by the electric arc welding process was given added impetus recently with the completion of a new building for the Lincoln Electric Company, Cleveland, Ohio.

The new structure connects two existing buildings and provides an increase in floor space of about 20,000 sq. ft. The new building is of the crane mill type, 200 ft. long and 100 ft. wide, and houses a 65-ft. electric, overhead traveling crane, as well as enclosing a two track railroad siding. This latter feature permits the unloading of materials, and the loading of outgoing shipments, within the plant.

The steel used in this modern building was completely shop fabricated by the arc welding process. Fig. 1 shows the construction of members in the structural shop of the Austin Company of Cleveland, who designed and erected the structure.

*The Lincoln Electric Co.

To support the roof 10 trusses 67 ft. long, placed on 20 ft. centers, were required. A typical truss as used in this building is shown in Fig. 2. To form the chords of these trusses, T sections were used. These T sections were obtained by splitting 15 in., 38½ lb. I beams down the center of the web. Each web member of the trusses is composed of two angles arc welded to the chords on opposite sides of the web of the T, and tied together by straps arc welded to the flanges of the angles.

FIG. 1.—WELDING OF MEMBERS

FIG. 2.—TYPICAL WELDED TRUSS

The crane runway and the 8 in., 33 lb. I columns which carry the roof trusses are supported by 18 in., 67 lb. H columns. The I columns are spliced to the H columns directly above the crane runway. These splices were made by arc welding ½ in. steel plates along the flanges and web of the columns. The crane runway is formed by 20 in., 59½ lb. I beams on top of which are placed the crane runway rails.

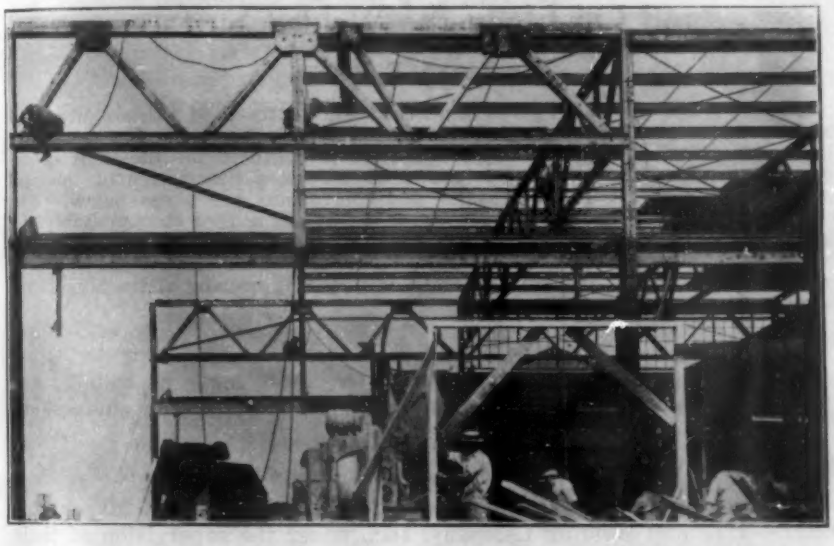


FIG. 3.—WELDED TRUSSES IN PLACE

Over the railroad tracks heavy trusses are required to distribute the load from the roof trusses to the columns, and also to carry the crane runway. These trusses are composed of 8 in., 17½ lb. I beams and heavy channels. Fig. 3 shows these trusses in place.

The simplicity of arc welded design allowed many improvements, and a great reduction in weight, by the elimination of many gusset plates and connecting angles, required in riveted construction. This factor coupled with the use of bolts to hold the various members in place during field erection reduced the cost of erection to equal that of riveted construction.

The increased use of arc welded construction has given architects and designers a chance to study construction by this process very thoroughly, and as a result many ways and means have been devised to reduce costs and time, and at the same time secure the most rigid and strongest possible construction.

An Experimental Investigation of the Strength of Welds as Effected by Coatings of Rust, Paint, and Oil Upon the Welded Surface

By Gordon F. Rogers

Editor's Note. The paper given below consists of extracts of a thesis submitted by Mr. Rogers for the Degree of Master of Science from the Massachusetts Institute of Technology, 1929. Because of the length of the thesis, it is impossible to reproduce it completely and, therefore, a description of the test specimens together with the results and conclusions are given below. The editor wishes to emphasize the remarks made by the author that probably the larger size bead accounted for the slight increase in average strength obtained with fresh paint as compared with clean material. This is published by permission of the Department of Civil and Sanitary Engineering of the Massachusetts Institute of Technology.

Object:

1. To determine the variation in the tensile strength of metallic arc welds due to coatings of rust, oil, and paint on the surfaces to be welded.

Specimens

Specimens were prepared by three different welders of the Manchester Engineering and Welding Company, Inc., under the supervision of their President, Mr. Paul B. Covey. A double strap tension specimen with fillet welds in parallel shear was selected and designed so that it would break at the welds at a stress just under the yield point of the parent steel. The dimension of the leg of the fillet was ¼ in. and each fillet was 1½ in. long. The welding wire conformed to the American Welding Society Specification E1B.

Welding

Each welder made five specimens for each of the six groups. These sets of five specimens were not made consecutively. The welders were required to make series of six specimens containing one specimen from each group.

Results of Each Group of Specimens:

1. Welding on Clean metal.
   a. These specimens rated second best in both ultimate strength and strength per linear inch of effective weld.
   b. Two specimens had bad gas pockets.
   c. There was poor fusion on one or more welds in three specimens.
   d. The welds in general were smooth and uniform.
2. Welding on Surface Rust.
   a. These specimens rated third in ultimate strength and fourth in strength per linear inch of effective weld.

b. Four specimens had bad gas pockets. There were a few slag pockets in three specimens.
c. In four specimens there were welds with poor fusion.
d. The welds in general were smooth and uniform.
e. On one specimen the welds seemed very brittle and broke with a bang with no apparent yielding.

3. Welding on Surface Covered with Fresh Oil.
a. These welds rated fifth in ultimate strength and third in strength per linear inch of effective weld.
b. There were bad gas pockets in *every* specimen and extra bad ones in three specimens.
c. There was poor fusion in just one specimen.
d. The weld metal was honeycombed with pockets, but usually there was a concentration of pockets at the base of the fillet.

4. Welding on Oil Soaked and Dried Surface.
a. These specimens rated sixth in ultimate strength and fifth in strength per linear inch of effective weld.
b. There were bad gas pockets in seven specimens. One specimen had a few slag inclusions.
c. In three specimens one or more welds had poor fusion.

5. Welding on Surface Covered with Fresh Paint.
a. These specimens rated *first* in both ultimate strength and in strength per linear inch of effective weld.
b. Seven specimens had had gas pockets. One specimen had a few slag pockets.
c. There was poor fusion in one specimen.
d. The welds seemed to be very ductile. In the testing machine these welds did not break with a small amount of yielding as the others did. Some welds elongated as much as one half inch before breaking.
e. The welds were generally large and rough due to the difficulty the welder had in working in the cloud of smoke from the paint.
f. The straps were separated from the end pieces by a heavy layer of paint. This made a larger volume in the notch to be filled with weld metal and thus a stronger weld. This is partly responsible for the high strength rating of this group.

Condition	Av. Ultimate Strength	Av. Lbs. Per Lin. Eff. In.	Max. Ultimate Strength	Min. Ultimate Strength	Max. % Variation from Av.	Max. ## Per Eff. Linear Inch	Min. ## Per Eff. Linear Inch	Max. % Variation from Av.
Clean Metal	(2) 46,565	(2) 8,837	49,540	42,340	9.06	9,710	8,270	9.88
Surface Rust	(3) 45,140	(4) 8,573	47,770	39,080	13.42	9,790	7,760	14.18
Fresh Oil	(5) 44,649	(3) 8,789	47,370	42,120	6.09	9,600	8,010	9.24
Dry Oil	(6) 44,245	(5) 8,515	49,550	38,940	12.00	9,550	7,410	12.98
Fresh Paint	(1) 48,059	(1) 9,033	52,160	44,910	8.53	9,900	8,100	10.33
Dry Paint	(4) 44,878	(6) 8,402	52,540	37,760	17.10	9,260	7,250	13.70
Total	45,589	8,691	52,540	37,760	17.13	9,900	7,250	16.60

AVERAGE TEST FIGURES—ALL SPECIMENS

g. In every respect except gas pockets these welds seem to be the best of any in the six groups.

6. Welding on Dry Paint.
   a. These welds rated fourth in ultimate strength and sixth in strength per linear inch of effective weld.
   b. Seven specimens had bad gas pockets and one specimen had a few slag inclusions.
   c. One specimen showed poor fusion.

Conclusions

From the results of the investigation as stated the writer believes:

1. That the relative tensile strengths of welds made under the conditions of this investigation are as indicated in the tabulation below.

	Rating	Ultimate Strength	Rating	Pounds Per Eff. Lin. In.
a. Fresh Paint	(1)	48,059	(1)	9,033
b. Clean Metal	(2)	46,565	(2)	8,837
c. Fresh Oil	(5)	44,649	(3)	8,789
d. Surface Rust	(3)	45,140	(4)	8,573
e. Dry Oil	(6)	44,245	(5)	8,515
f. Dry Paint	(4)	44,878	(6)	8,402

2. That from a tensile strength standpoint the variation in strength of welds is not large enough to require surface rust and mill scale, oil and mill scale, or paint and mill scale to be removed before welding.

3. That these impurities should, nevertheless, be removed from the steel before welding for the following reasons:
   a. The impurities create gas pockets and slag inclusions in the weld metal.
   b. Welds with gas pockets are weak in shock resistance.
   c. Clean metal gives a higher tensile strength in every case considered except fresh paint.
   d. It is much easier for the welder to do a good job on clean metal.

4. That with paint and oil the time factor is more important than the volume of these substances present. A thin coat of either liquid that is allowed to soak in and dry has a worse effect on the subsequent welds than an excess of the fresh liquid applied just before welding.

5. That red lead paint applied to the surface of the steel immediately before welding gives a more ductile weld than that produced by any other condition of this investigation.

6. That within the small range of ultimate strength values obtained in this investigation the writer was not able to accurately predict the strength of the specimens in grading them before testing.

Welding Developments in 1929

Editor's Note—A brief review of the welding developments during the year 1929 has been prepared by a Committee of the American Welding Society. For the sake of convenience these developments have been divided among the four different welding processes. However, items listed under one are sometimes applicable to the other processes.

Owing to the manner in which it has been prepared, it has been found necessary to omit refererces to general developments and research work. Attention is called, however, to the fundamental studies in the welding field by some ten of our prominent universities aimed at increasing our knowledge of the fundamentals of welding. Also among the general developments may be mentioned a Code prepared by the American Welding Society on "Fusion Welding and Gas Cutting in Building Constructior," and a report on "Nomenclature, Definitions and Symbols."

There have also been developed, during the past year, several methods for non-destructive tests or examinatiors of welded structures which are bound to prove of great service in connection with certain important applications of welding to industry. These methods are: Stethoscope, X-ray and two varieties of electro-magnetic methods.

ARC WELDING

Structural Steel

THE application of arc welding to structural work continued, during 1929, to be an activity arousing great interest, both popular and technical. The possibility of erecting buildings by this method, thus quieting the clamor in large cities, was principally responsible for the public interest, while the economic advantages, such as savings in weight, were further demonstrated for the benefit of architects, builders and engineers.

The number of buildings and structures erected by the use of arc welding materially increased during this period. The first statistics of this nature were prepared by Frank P. McKibben in July, 1928, when he listed 100 structures consisting of bridges and buildings. In July, 1929, the total had increased to 138. The number of welded buildings alone jumped from 43 to 65, a 50 per cent increase.

Further demonstration of the reliability of welding as a method of fabrication was found in the results of a two-years' series of tests on welded joints conducted at the Rensselaer Polytechnic Institute. Conclusions based on these tests indicated that the application of arc welding to the construction of buildings was no longer in the experimental stage, and that such construction can now be made with complete safety and with entirely successful results.

Widespread activity among municipal and State bodies was noted throughout the year in the adoption of ordinances and laws allowing the use of welding in building construction. During the year, 52 municipalities in the western and southern parts of the country had sections

in their building code covering this point, and many followed suit elsewhere. The Legislature of the State of Pennsylvania had passed a law allowing the type of construction to be used in first-class cities. Municipalities below that grade were already free to adopt their own codes.

A model ordinance was framed by the American Welding Society and it was submitted to municipalities for consideration. Pittsfield,

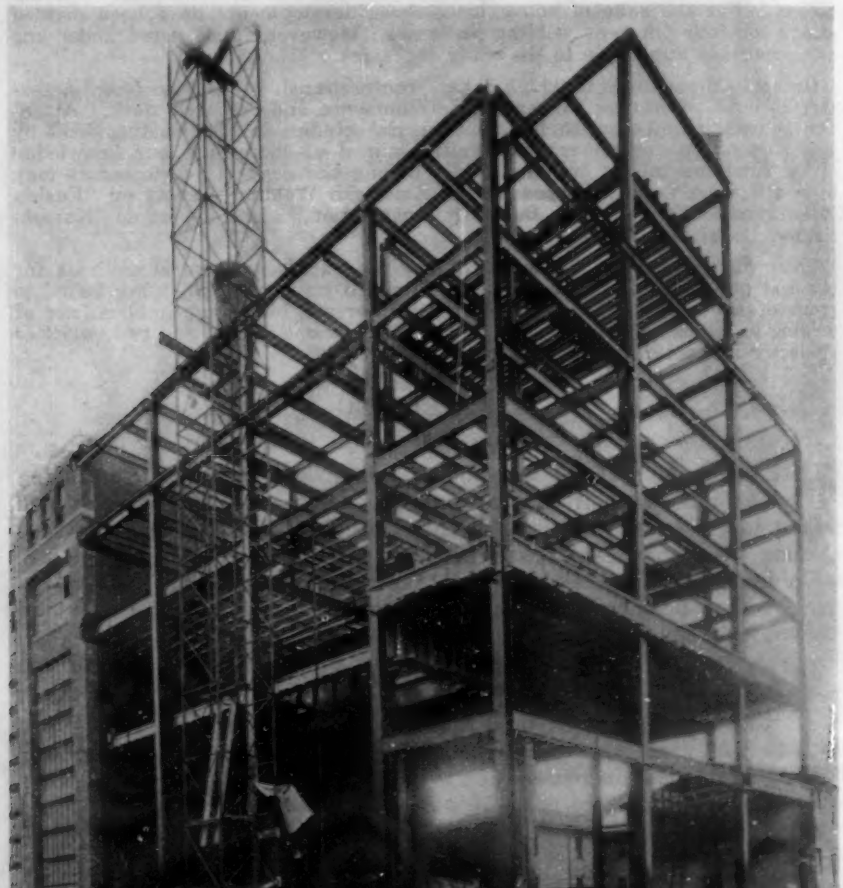


FIG. 1.—ARC-WELDED POWER HOUSE FOR HADDON HALL-CHALFONTE HOTEL, ATLANTIC CITY, N. J.

Mass., was the first city in the country to formally adopt this new building code. In addition, Pittsfield was the first truly eastern city to incorporate welding in its code in any form.

Many interesting applications of welding to this type of construction were made during 1929, of which a few outstanding examples may be chosen as illustrations. Early in the year an extension to the power house of the Haddon Hall and Chalfonte Hotels of Atlantic City was completed, quickly and quietly, without disturbing the guests of either hotel or the residents of the cottages in the neighborhood. This power

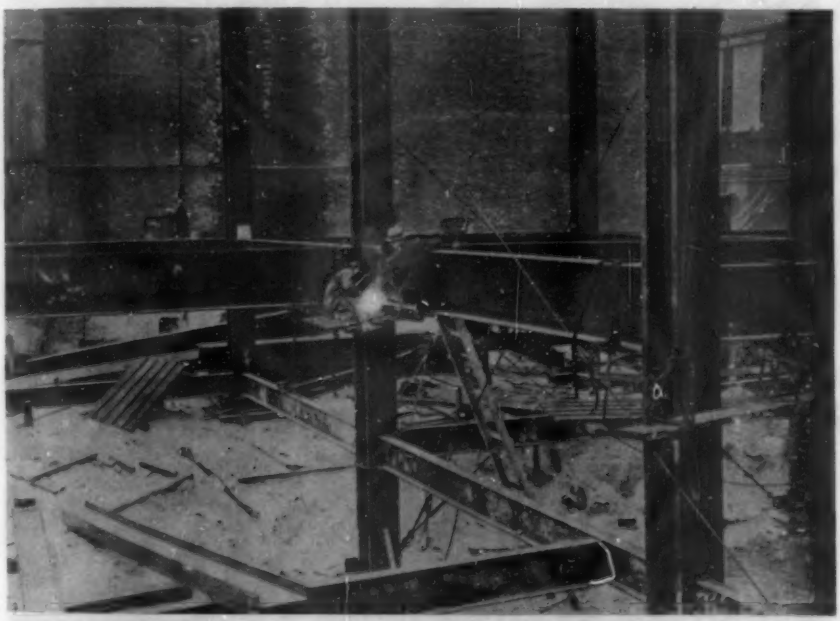


FIG. 2.—WORKMAN ARC WELDING FRAMEWORK OF CHALFONTE-HADDON HALL, ATLANTIC CITY, N. J.

house has a height of 134 ft. and is one of the tallest welded-steel building frames in the world. Some of the steel columns supporting the building and its heavy contents are of the heaviest type of steel shapes used in building construction. The hotels are owned by Leeds & Lippincott Company, the architects were Rankin & Kellogg of Philadelphia, the engineers were Carson & Carson of Philadelphia, and the steel contractor was the Bethlehem Steel Company.

At the present time a 12-story office building is under construction for the Southern California Edison Company at Los Angeles, which will contain approximately 3600 tons of steel. All of the wind bracing and seismic bracing is to be arc welded in addition to other details. According to the information at hand, the building will be 75 per cent an arc welded job.

A highly important contribution to the building art was announced by the American Institute of Steel Construction at its seventh annual convention at Biloxi, Miss., Nov. 14. This was the development of a new type of arc welded steel floor which materially reduces the weight of the structure. This floor construction, known as "battledeck" type, was demonstrated by the erection of a sample structure during the convention in the presence of the Institute members. Electric welding plays an important part in the development, a special automatic arc welding machine being used to "stitch" together the plates and beams which form the flooring. The resulting structure met all specifications and tests satisfactorily.

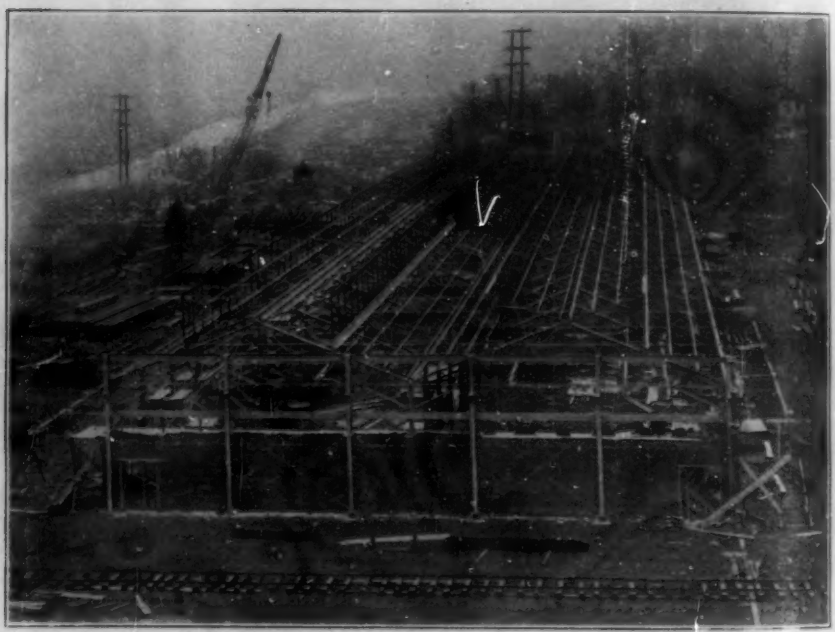


FIG. 3.—PART OF LARGE U-SHAPE WELDED FACTORY BUILDING. ONE PORTION IS 133 FT. LONG BY 60 FT. WIDE BY 25 FT. TO BOTTOM CORD OF ROOF TRUSS, SECOND IS 460 FT. LONG BY 100 FT. WIDE BY 25 FT. HIGH, THIRD PORTION IS 440 FT. LONG BY 62 FT. WIDE; 301 FT. OF WHICH IS SINGLE STORY 65 FT. TO ROOF TRUSS AND THE REMAINING 140 FT. IS THREE STORIES IN HEIGHT. STEEL TONNAGE APPROXIMATELY 780 TONS

The new flooring utilizes steel plates and structural steel beams. It is, according to the Institute, better than any floor that has been used before, and will stand every service to which the floor may be subjected.

The new floor is described as being a solid steel deck which acts as a girder to prevent any torsional distortion of the building when subjected to wind or earthquake action.

The total cost of a floor constructed of 3-in. I-beams and 3/16-in. plates, covered on the top with cork tile and fireproofed on the underside, is estimated by the Institute as being a little over $1 per square foot.

The new steel floor, says the Institute, is equally applicable to residences, multiple-story buildings and bridges. For building construction it will save from 20 to 60 lb. per square foot of floor in dead weight. In connection with a 75-story building with floor panels 21½ ft. x 22½ ft., the saving in dead load on the foundations for each column is nearly two million pounds, this indicates that its use will permit an increase of 25 per cent or more in the height of the building or in the number of floors without increasing the loads on the foundations.

FIG. 4.—ILLUSTRATES 80 FT. SPAN ROOF TRUSSES CONSTRUCTED ENTIRELY OF V SHAPES. THE BOTTOM CORD AND RAFTER BEAMS BEING OBTAINED BY SPLITTING THE CARNEGIE BEAMS. THE PANEL MEMBERS ARE STANDARD COMMERCIAL V SECTIONS. THE WEBS AT THE ENDS OF THE PANEL MEMBERS WERE CUT AWAY AND SLOTTED IN LINE WITH THE WEB SO THAT THE REMAINING PORTION OF THE FLANGES WOULD SLIP OVER THE WEBS OF THE BOTTOM CORD AND RAFTER MEMBERS

Vehicular Tunnel Construction

An interesting application in which welding played an important part was the construction of the new vehicular tunnel running under the Detroit River between Detroit and Windsor, Canada. This tunnel was built on dry land in sections which were afterwards launched, floated into position and sunk to their places on the bottom of the river. The work was carried on by the Canadian Bridge Company at Ojibway, Canada, six miles down the river from the tunnel site. Arc welding was utilized for caulking purposes around the full circumference of the shell in 42 places and for 1100 ft. of welded butt-joints.

Repair of Railroad Bridges

The accompanying photograph illustrates the application, during 1929 of arc welding to the repair of a large railroad bridge in the vicinity of Pittsburgh, Pa. This bridge, of the pin-and-link type, is a through-truss structure of three spans over the Kisimenetas River.

Ship Construction

Metal arc welding was much more extensively used during 1929 in the construction of merchant and naval ships. In both cases the policy pursued was a gradual utilization of the process, rather than an attempt to weld the complete ship. In merchant ship construction the object is primarily a reduction in cost, while in naval work the object is to save weight.

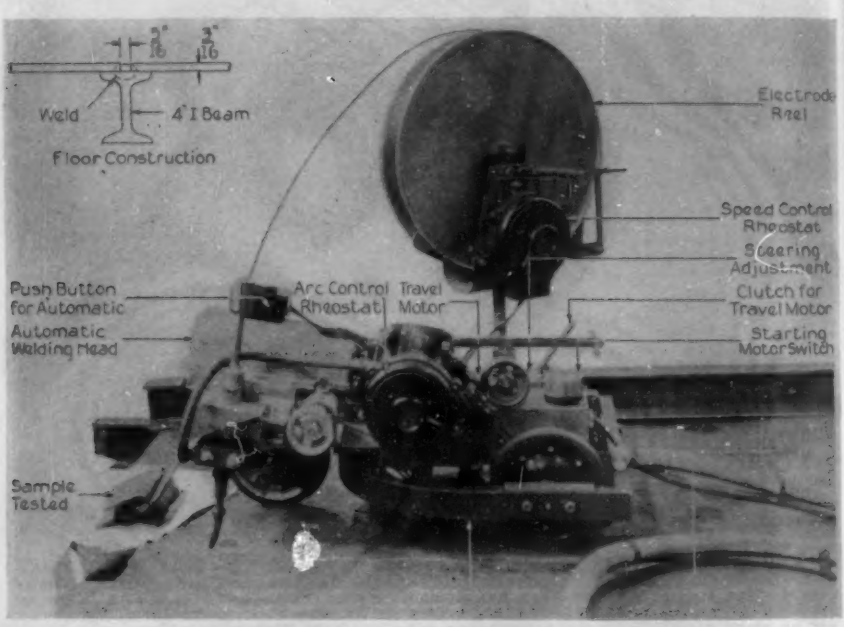


FIG. 5.—AUTOMATIC DEVICE FOR WELDING ALL STEEL FLOOR

International attention has recently focused on arc welding in naval construction, because the weight saved by its use materially assisted the German Navy to mount 11-in. guns on their new 9000-ton cruisers.

The 613-ft. S.S. "Pennsylvania," built by the Newport News Shipbuilding & Dry Dock Company and launched July 10, 1929, like her sister ships, the "California" and "Virginia," embodied sufficient welding to require the use of approximately 45,000 lb. of electrodes in her construction. Welding was also used extensively in the 272-ft. yacht "Viking" for George F. Baker, built by this company and delivered April 27, 1929. In this case the utilization of welding greatly assisted the architects in obtaining the desired graceful lines.

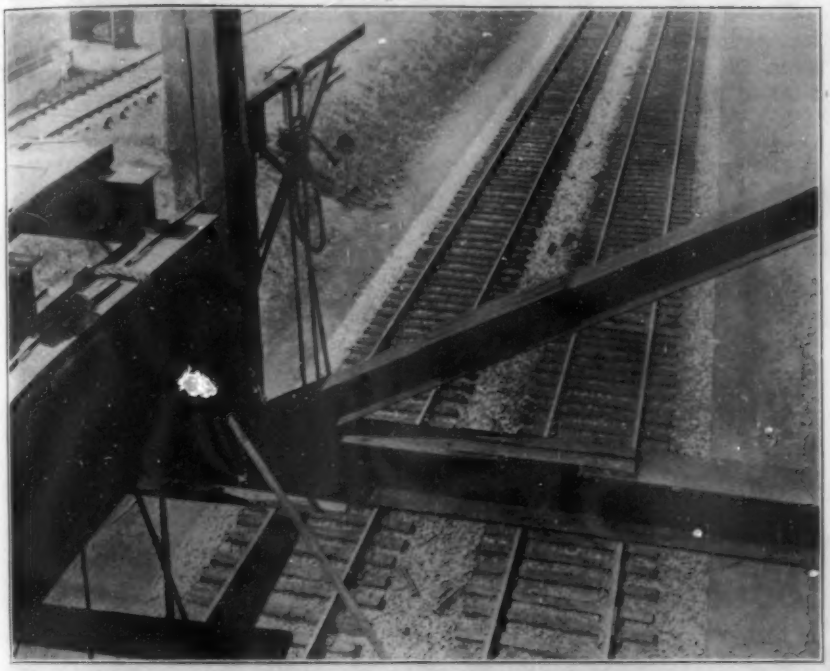


FIG. 6.—REPLACEMENT OF RIVETED GIRDERS AND GENERAL REENFORCING OF A HIGHWAY BRIDGE USING ARC WELDING. CONSTRUCTION FOR A LARGE AMOUNT OF WORK OF THIS GENERAL TYPE HAS BEEN DONE AT A NUMBER OF PLACES THROUGHOUT THE UNITED STATES IN THE PAST YEAR

FIG. 7.—RAILROAD BRIDGE OVER KISKIMINETAS RIVER, REPAIRED BY ARC WELDING, NEAR PITTSBURGH, PA.

The Federal Shipbuilding and Drydock Company of Kearny, N. J., has recently completed five all-welded channel-type scows about 116 ft. long, 34 ft. wide and 10½ ft. deep, and is constructing two scows of similar type that are 175 ft. long.

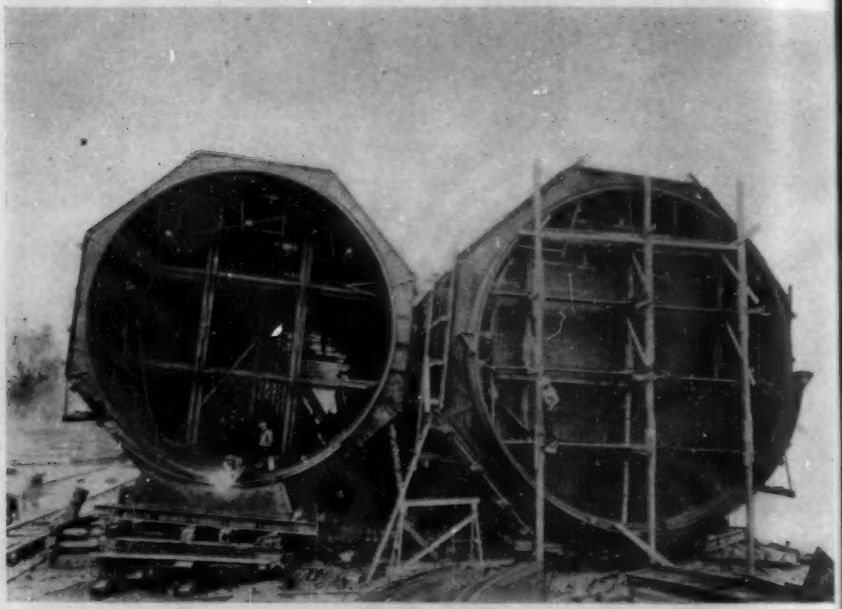


FIG. 8.—ARC WELDED DETROIT VEHICULAR TUNNEL SECTIONS ON ASSEMBLY AND LAUNCHING WAYS. WELDERS WORKING. END VIEW. OJIBWAY, ONTARIO

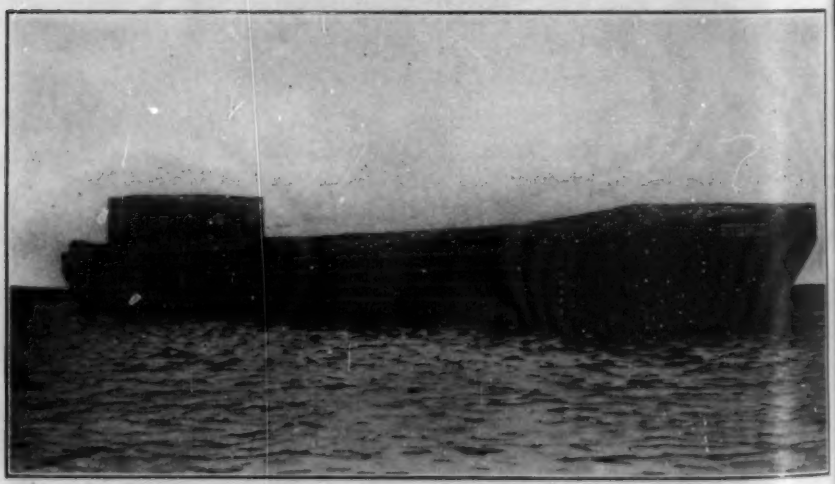


FIG. 9.—ALL WELDED BARGE OF THE ELECTRIC BOAT CO.

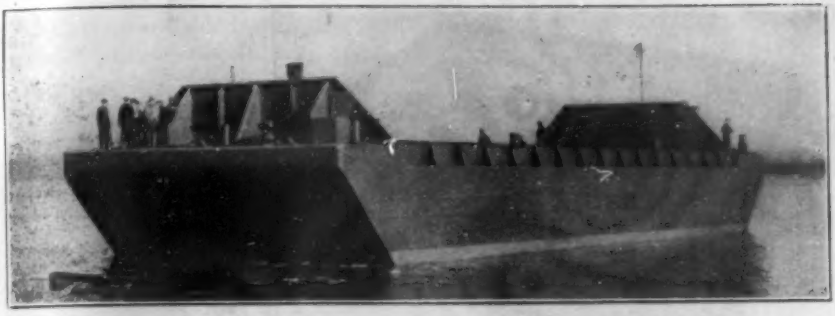


FIG. 10.—WELDED SCOW OF THE FEDERAL SHIPBUILDING AND DRYDOCK CO.

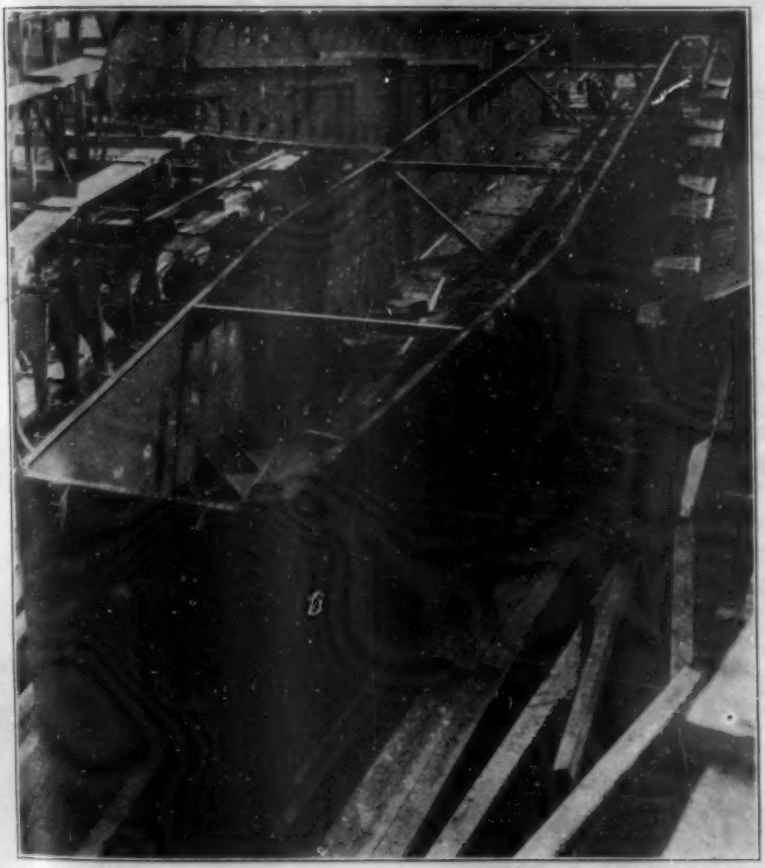


FIG. 11.—COMPLETELY METAL ARC-WELDED INBOARD SHAFT ALLEY BULKHEAD ON S. S. MORRO CASTLE AND S. S. ORIENTE UNDER CONSTRUCTION AT THE PLANT OF THE NEWPORT NEWS SHIPBUILDING AND DRYDOCK CO.

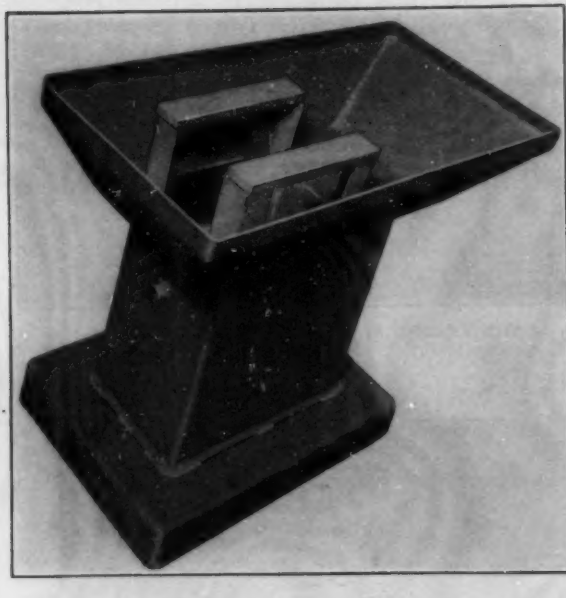


FIG. 12. — VIEW OF A BASE BUILT FOR THE OSTER MANUFACTURING COMPANY'S NEW PRODUCTION CUT OFF MACHINE FOR BAR STOCK AND PIPE.

The arc welded base weighs only 825 lbs. Its predecessor of cast construction weighed 1150 lbs. The arc welded steel base is also stronger and more rigid and costs less to produce. The container or splash pan of the base is made of one piece of sheet steel partially formed on a press and also cut and then fabricated by arc welding. The oil sump contained within the pedestal or upright member is also of one piece of sheet steel, cut and formed, then fabricated and joined to the splash pan and pedestal member by arc welding. Two pieces of sheet steel formed into channels with flanged edge at one end are butt welded together to form the pedestal member. The lower member or base of pedestal is of one piece with edges flanged and joined by arc welding. The uprights supporting the bed plates for the machine are sheet steel, formed into right angles and welded in place. The bed plates composed of flat bar stock, are laid across the tops of the uprights secured by arc welding. The various members of the base are then assembled into one piece construction by the electric arc

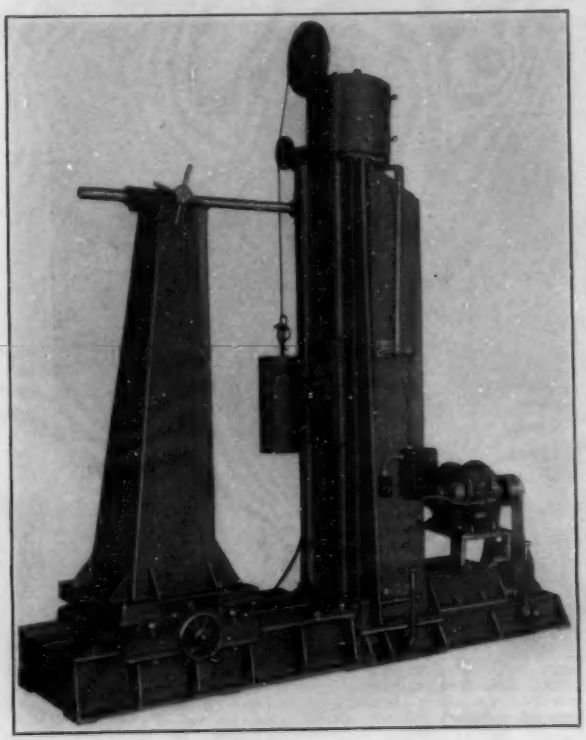


FIG. 13.—TEE SLOT MILLING MACHINE MADE OF ARC WELDED STEEL BY POTTER & JOHNSON MACHINE COMPANY, PAWTUCKET, R. I.

The pleasing appearance of this machine should be noted. This was a special machine and a saving of around 50 per cent was effected. Note its construction.

The Truss-Weld Barge Corporation launched an 8000-bbl. capacity gasoline tanker 134 ft. long.

Also, the Electric Boat Company has just completed a 1000-ton cargo deck barge, 118 ft. x 10.5 ft., of the all-welded Ewertz patented design. It will be interesting to note that in the construction of this barge some 150 tons of steel was used and that it required 18,000 linear feet of welding, using about 3500 lb. of welding wire.

The Fore River Yard of the Bethlehem Shipbuilding Corporation delivered two colliers 350 ft. long with transverse seams of their tank tops welded and with bulkheads wherein two rows of rivets were replaced by one row and a continuous weld.

At the present time there is under construction at the Charleston

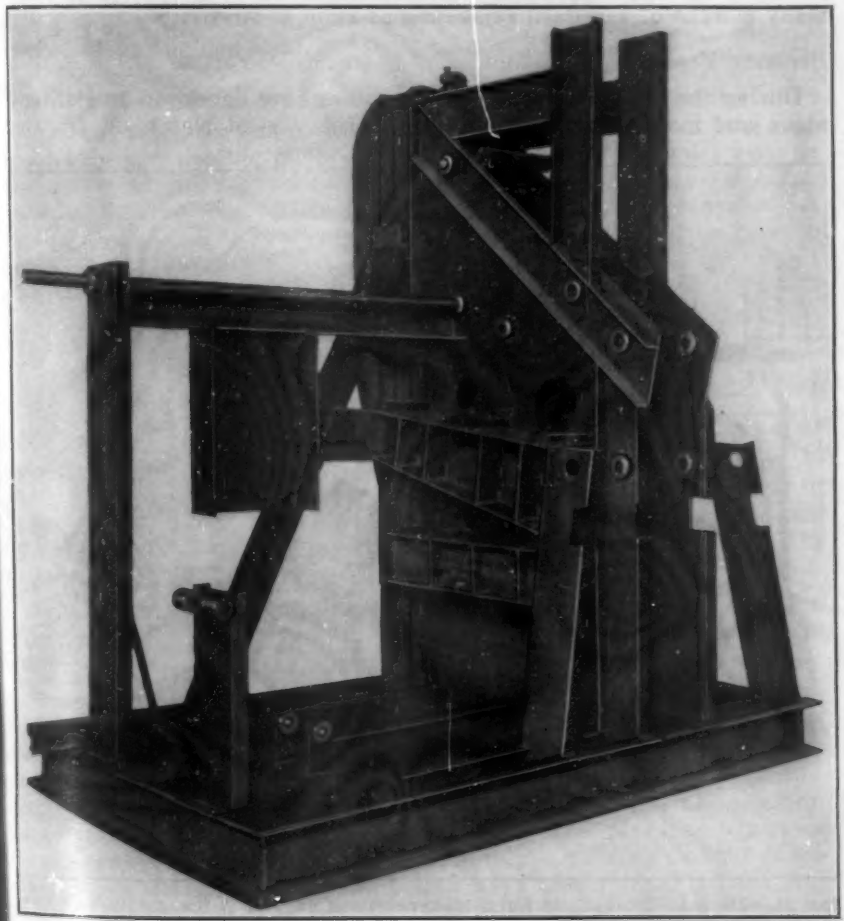


FIG. 14.—FRAME FOR COKE PUSHER MANUFACTURED BY THE GAS MACHINERY COMPANY, CLEVELAND, OHIO

This is an excellent example of the use of welded steel for complicated or intricate framework or bases for machinery

Dry Dock and Machine Company a completely welded 120-ft. oil tanker and at the Standard Steel Shipbuilding Corporation, Los Angeles, Cal., a 65-ft. yacht. Two merchant ships, the "Morro Castle" and "Oriente," are also under construction at the plant of the Newport News Shipbuilding & Dry Dock Company for the Atlantic Gulf and West Indies Navigation Company. The outstanding new applications on these ships are the completely welded inboard shaft alley bulkheads shown in Fig. 11, masts, and bilge keels.

Pile Drivers

There was also constructed by arc welding four pile drivers by the Mississippi Valley Structural Steel Company of Melrose Park, Ill., for the Walsh & Masterson Company of Chicago. These machines are subject to very heavy duty, involving terrific vibration, night and day. After many months of service they showed as rigid as first built.

Pressure Vessels

During the past year or so two companies have developed special technique and methods for arc welding of heavy steel plates, oil cracking

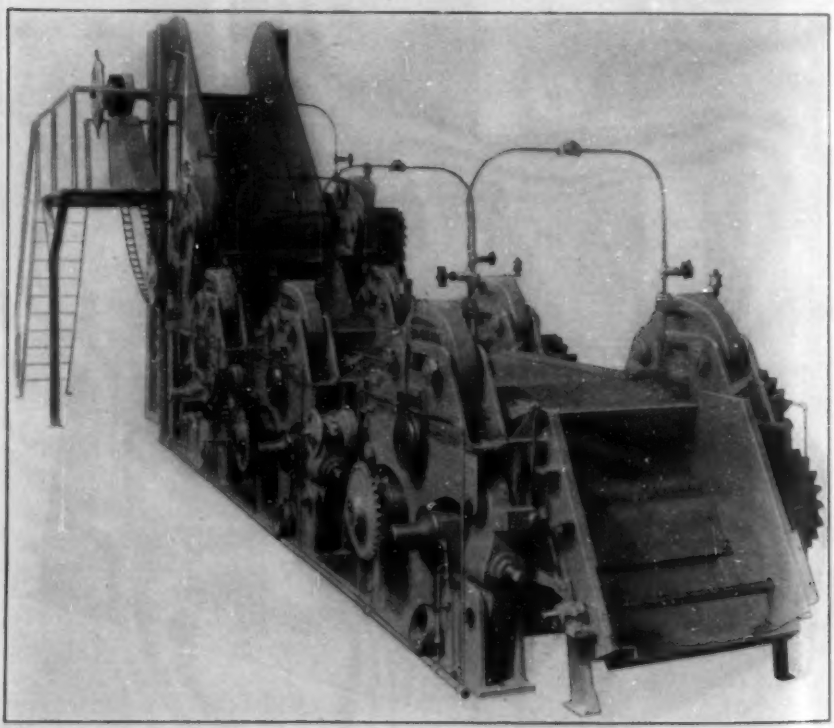


FIG. 15.—MODERN SUGAR CANE MILL MANUFACTURED BY THE BAHMANN IRON WORKS, CINCINNATI, OHIO

The housings are built entirely of heavy steel plate. The bearing supports are worthy of notice. The small bosses are merely inserted through the holes in the housing frames and are welded in place. The base of the housing frame is formed by a steel plate arc welded to the vertical members

stills, and other high pressure vessels. One of these companies, for example, has manufactured over a thousand vessels using over 70,000 tons of plates averaging about 3 in. in thickness. Excellent ductility and tensile strength was obtained by the use of special alloy covered electrodes, high current values, and annealing of the structure after welding.

Machinery Construction

One of the greatest developments of 1929 in the arc welding field has been the universal acceptances of the use of welded steel to replace castings. The possibilities in this field are tremendous. One authority states that, in his opinion, nearly 75 per cent of the 800,000 tons of castings produced in 1929 could be replaced advantageously by welded steel. Examples are given in the illustrations. One example may be cited in the welding of a 160,000-kw. turbo generator which was recently constructed of arc welded steel.

Pipe Welding

A marked tendency was noticed during the year to construct long pipe lines by the arc welding method. Among the notable examples may be cited a 205-mile pipe line built during the year and running from Jal, N. M., to El Paso, Tex. This line is 16 in. in diameter and carries gas for the El Paso Utilities Company. Among other large lines may be mentioned the Monahans-Port Arthur line, 714 miles, largely 12 in.; small amount of 10-in. pipe; line from Cushing, Oklahoma-Chicago, 832 miles, largely 12-in. pipe; and the Gas line through Rock Springs-Ogden-Salt Lake City, 270 miles, largely 16 and 18-in. pipe.

OXY-ACETYLENE WELDING

An additional year of experience with welded structures of all kinds, including piping, pressure vessels and other equipment subjected to severe service, without failure, has created widespread confidence in fusion welding and made its acceptance among engineers more general than ever. This has been reflected in increased volume of business in materials and supplies for welding.

Developments in particular fields of welding and in general have been extremely gratifying during the past year. These include fundamental work, applied welding and contemporary aspects.

The Structural Steel Welding Committee of the American Welding Society is completing its work. Regulatory matter in the form of a Building Code for Structural Welding has been prepared by the American Welding Society and distributed throughout this country and Canada. Sixty-eight cities in the United States have made provisions to permit structural welding under specified conditions. The year has witnessed the successful construction of a 300-ton, mill-type building entirely fabricated by gas welding. Structural details have been worked out for projected additional mill-type and multi-story buildings. Noise abatement committees are calling public attention to welding as a means of silent building construction.

The Aircraft Welding Procedure Committee of the American Bureau of Welding completed its work. The Bureau of Standards has conducted an investigation of welded joints for aircraft construction in cooperation with the oxy-acetylene industry, and the latter has adopted a definite program of cooperation with aircraft manufacturers for the purpose of improving present standards.

The Boiler Code Committee of the American Society of Mechanical Engineers has made further provision for welding.

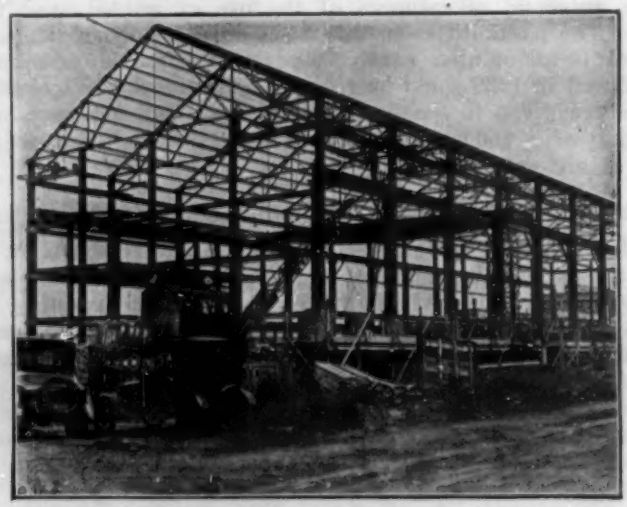


FIG. 16.—300-TON MILL-TYPE STEEL BUILDING FABRICATED ENTIRELY BY OXY-ACETYLENE WELDING

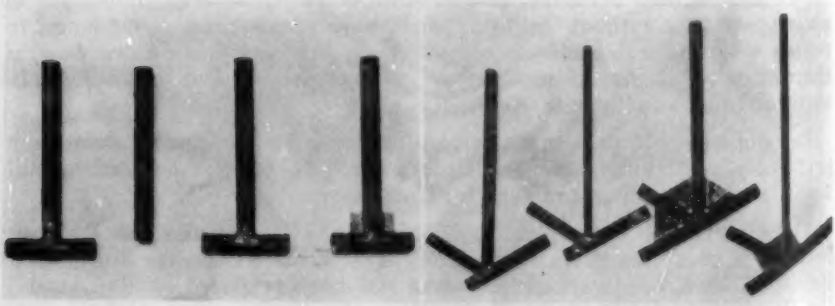


FIG. 17.—TYPICAL FUSELAGE JOINTS TESTED BY BUREAU OF STANDARDS

Non-destructive methods of testing have reached the stage where they may be applied to a routine manner. One test of this type is the stethoscopic method which can be applied to practically all welds whether of symmetrical shape or not. It provides a portable means for examining completed welds. In any testing procedure the tensile strength

of any section of a weld can be estimated to within 3000 lb. sq. in. The latter is at present a laboratory method, but may be made portable in the future for use in important work. Electrical resistance testing has proved very successful for small cross-sections. Magnetic testing shows promise, but is as yet only experimental.

Steel welding rods of new composition have been developed which will easily produce full strength welds in the stronger materials lately introduced, such as steel line pipe of increased carbon content. High-strength bronze welding rods have also been introduced with marked success

FIG. 18.—STETHOSCOPIC TESTING OF WELDS

which are increasing the application of the versatile bronze-welding process. These welding rods are among the products of the extensive research laboratories, supported by the industry, which are constantly contributing to the advancement of welding through pure and applied research.

Dissemination of knowledge of the oxy-acetylene process has been materially increased through cooperation with engineering colleges and the distribution of carefully prepared instructive literature covering both general and specific applications. Design and application standards for welded steel and wrought-iron piping construction have been promulgated by one of the large manufacturers of welding gases as well as a training course for aircraft welders.

Most important, from the point of view of the welding industry and users of the oxy-acetylene process, is the extension of the use of "Procedure Control." A Procedure Control is a definite production specification, written for a particular welding project, describing in detail the

procedure to be followed. Procedure Controls, originally used for pipe line construction and subsequently applied with equal success in other fields, are being extended to cover additional applications. Experience has proved that Procedure Control methods minimize the human factor and assure uniform high quality results in production welding.

Gas welding of steel piping systems and overland lines has progressed to the point where engineers unhesitatingly specify them for any pressures now considered practical, provided proper procedure is followed in their construction. Steam piping operating at temperatures up to

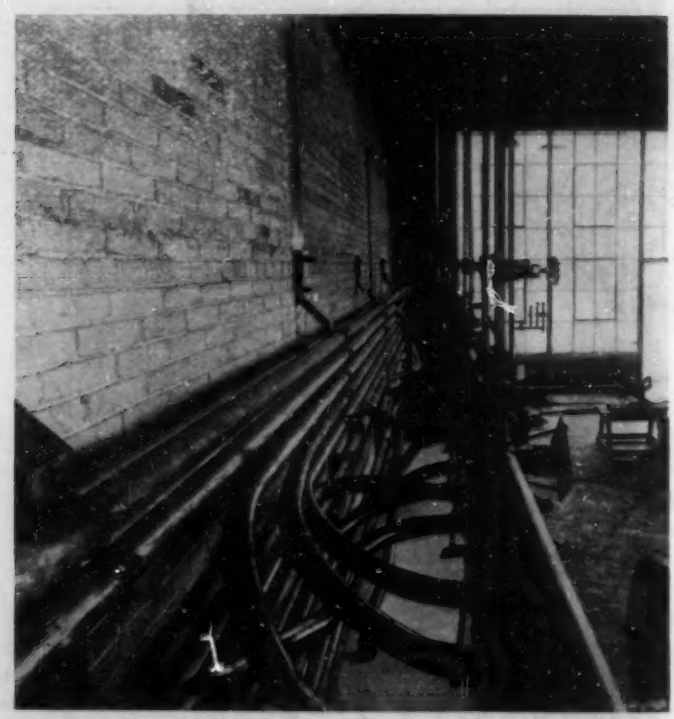


FIG. 19.—HYDRAULIC LINES TESTED AT 5000 LB. PER SQ. IN., WORKING PRESSURE 3500 LB. PER SQ. IN.

and including 750 deg. Fahr. is now in operation. Gas transmission lines carrying pressures around 1000 lb. per sq. in. have been operating during the past year. Welded hydraulic piping for working pressures as high as 5000 lb. per sq. in. is also in use.

The appearance on the market of fittings especially designed for welding evidences the general acceptance of welding as a standard method of construction for piping systems.

Welding has been definitely recognized by the heating and plumbing contractors. Their official organization, the Heating and Plumbing Contractors' National Association, has started the standardization of welding practice for heating piping, and is now preparing, in cooperation

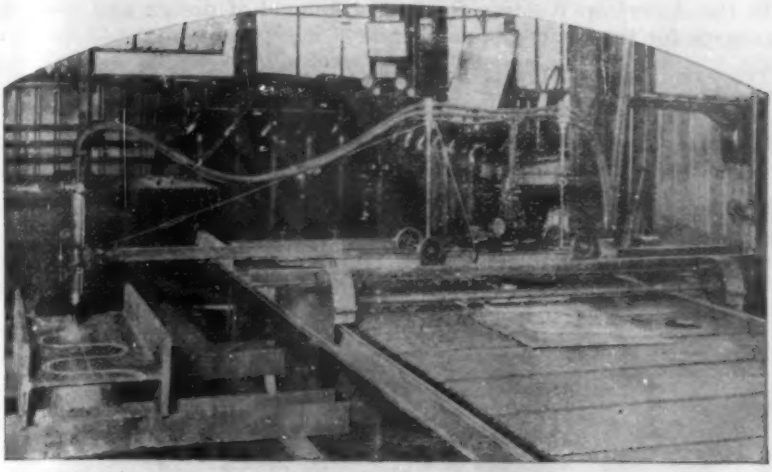


FIG. 20.—OXY-ACETYLENE SHAPE CUTTING MACHINE IN USE

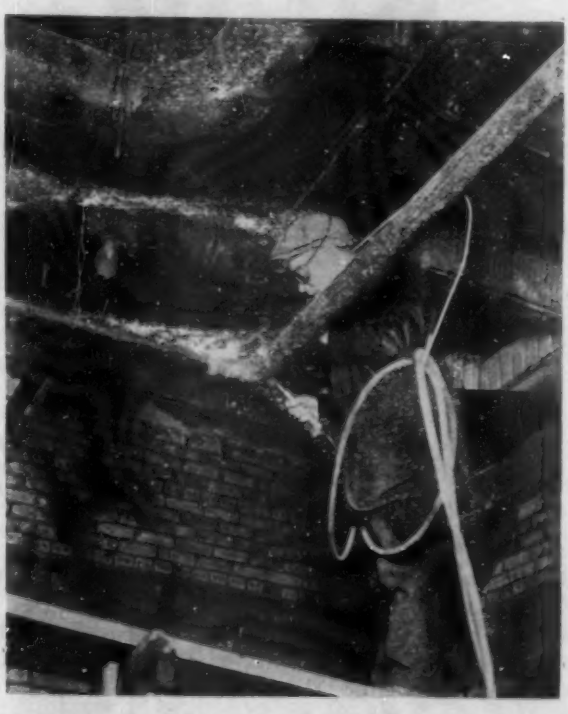


FIG. 21.—ALL PIPING OXY-ACETYLENE WELDED IN CHICAGO SKYSCRAPER

with the American Welding Society, a manual of design and application standards for the use of its members.

The chemical industry is now constructing much of its equipment by welding.

Oxy-acetylene shape cutting machines are finding increased application in the economical forming of steel plate and heavy sections.

Further refinements in the design of welding and cutting apparatus, acetylene generators, welding rod and accessories have been accomplished A very complete line of generators, regulators, blowpipes and accessories is now available, from which equipment may be selected that is espe-

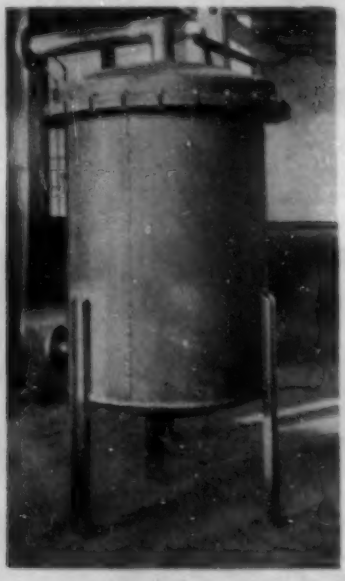


FIG. 22.—OXY-ACETYLENE REACTION TANK IN CHEMICAL PLANT

cially suitable for almost any type of work, and extremely reliable and durable. All such equipment is designed for consistent performance and maximum production with minimum fatigue to the operator.

Application of oxy-acetylene process has been increased in many fields, including steam and electric railways, power plants, commercial and domestic refrigeration, ferrous and non-ferrous foundries, steel mills, marine, structural steel, automobiles, aircraft, chemical plants, job welding shops, pipe lines, industrial piping, heating and ventilating, unfired pressure vessels, boiler welding, bronze and copper welding, hard-facing metals, mechanical gas welding, machine cutting, scrapping, and heat-treatment.

RESISTANCE WELDING

One of the outstanding developments during the past year is the large increase of the semi-automatic and the complete automatic types of resistance welding machines. With semi-automatic or automatic machines, production can be doubled, and quadrupled, per man per welder as compared with hand operated machines. This change has been accompanied by the use of large welders even on small jobs. At the present time most of the welders sold are of 150 kva. or greater, yet some of these welders only weld a cross-section of about ¾ sq. in., but they do it extremely quick; namely, that the amount of power required is inversely proportional to the time in which the weld is made.

Many parts of automobiles, trucks, tractors, farm machinery, etc., which were formerly made from drop forgings or steel castings, are now being made from stampings or drawings and welded together.

The last year has seen the use of the resistance welder in connection with high pressure boilers for practically the first time; also they are used for welding various alloys, such as Everdur, Ascoloy and other alloys to give rustless, stainless, pitless tubes for high pressure stationary boilers which operate at very high steam pressure as well as at high superheat of steam.

More steam railroads have begun to resistance weld the safe ends of their flues and tubes. About a dozen of our largest railroad systems have now completely abandoned the use of oil and gas forges for this work and have adopted the quicker, cleaner, stronger resistance welding method for this work.

The year of 1929 has seen the installation of the first locomotive tire heater for electrically expanding locomotive drivers or tires preparatory to shrinking them upon the locomotive drivers.

During the last year or two, practice of using the small resistance welder for a cutting-off machine has become very common. Especially is this true in the severing of stranded steel cables for various uses, and for use in connection with four-wheel brakes on automobiles and trucks. This method is also used for cutting off the stranded wire for use in the inside rims or clinchers of automobile and truck tires. Formerly when it was desired to cut this stranded cable in two, it was necessary to first solder a thimble over the wire, then saw through the thimble, then remove the thimble again. By means of this electric cutting-off process, no thimbles are required and the wires are all fused together in a solid lump which will not unravel.

The last year has seen an enormous advance in the use of resistance welders for joint large sizes of pipes. Up to a year or two ago, about 6-in. diameter was the largest pipe to be satisfactorily butt welded together; now it is common practice and quite easy to weld 8 in., 10 in., 12 in., and even much larger diameters of pipe, up to 28 in. or 30 in., and there seems to be no limit in this direction except as to the amount of money the customer is willing to pay for the machine and the amount of power he can secure to operate it.

Relatively large cross-sections of copper strips and bars are now welded by the resistance process, by means of especially designed and built copper welders. Until recently about ¼ in. to ⅜ in. diameter copper bars was the largest work that could be satisfactorily done by this process. Here again the limit as to the size of work which can be done is determined by the power available.

Another development is the use of the resistance welder for precision work such as reamers, cutters, drills, dies and many other fine tool jobs requiring the work to be held to a limit of a very few thousandths of an inch. Up to a year or two ago, a resistance welder was considered a blacksmith's tool only, and a difference of a sixteenth of an inch or so in alignment was considered perfectly satisfactory. Now, however, as stated before, the resistance welder is a precision instrument that is able to hold its work to very narrow limits. This precision is of great benefit in the welding of thin sheet steel, such, for instance, as band saws, high carbon steel for safety razor blades, and other work where a misalignment of a very few thousandths would cause rejection.

Aluminum welding is going forward by leaps and bounds. Window frames are being welded by resistance welding at the four corners, much the same as steel frame welding is now done. Kitchen utensils of all kinds have handles and bails welded in place.

While projection welding itself is an old idea, it was never used very much until within the last two or three years. Now, however, it is being used for many new and novel purposes in many industries, but more especially in connection with the automotive and truck industries, and to a somewhat lesser degree in the manufacture of toys, skates, farming utensils, etc. The theory is that instead of making spots with two tapered spot welder dies, wherein only one spot at a time can be successfully made, by making projections on the work itself, either on one or both pieces and then coming down on the pieces with flat dies, a number of projections can be welded at the same instant, which, when completed, is very similar in character to a spot weld, but is stronger and more uniform, and at the same time there is no indenture on either the top or bottom surface of the work as there is in case of spot welds. This leaves the surfaces of the work perfectly smooth, so that after ducoing or japanning or painting, there is no mark or indication as to where the projection weld is made. This method lends itself very readily to the manufacture of metal furniture, lockers, running boards for automobiles, stiffening strips on automobile cowls, ears on buckets and cans, reinforcing strips on sheets of all kinds.

One thing that held back the general adoption of projection welding for many years was the fact that there was no suitable material for dies that would stand up very long, especially when a number of projections were made at the same point of the die. Now, however, there are two or three materials that stand up very much longer and lend themselves quite well to the process of projection welding. Foremost among these materials is an alloy consisting largely of copper, tungsten and some other ingredients in small quantities.

THERMIT WELDING

Thermit welding has made some very rapid strides during 1929, the outstanding features of which have been the development of a method for the welding of open track which ought to find a large application in steam railroad work. This development was covered by a paper presented before the annual meeting of the American Welding Society, April 25, 1929. A great deal of this work has been done abroad, and for a long enough period to prove conclusively that the weld is equal to the rail in its physical properties and in wear resistance, and that welded rail properly installed will give little or no trouble from expansion due to temperature changes. It should find immediate application in the elimination of rail joints in stations, terminals, on bridges and in tunnels, and within a few months practical experiments for the welding of long lengths of main line track and yard track should prove in all probability that conditions in this country are no different than abroad, and that lengths of one thousand feet and over can be welded up solid with ordinary bolted joints at the end. Much work is still to be done on this in this country, but abroad more than sixty thousand joints were installed on main line track last year. The pressure welds in the New York Central De Witt yards at East Syracuse have been in now a little over a year, and a recent inspection proved it to be practically impossible to locate the welds.

The use of Thermit in the welding of paved track has increased to a point where it is now considered as standard practice by many of the trolley roads of the country. The welds have been of the insert and the under-cut variety, both of which have proved their lasting qualities since originally installed in 1912. The under-cut method limits the installation work slightly, because of the necessity of butting the rail ends together as each joint is made, and it is for this reason that the majority of the work is done with the use of inserts.

For years there has been a demand for the installation of Thermit rail welds without interruptions to traffic, and this was very successfully worked out and developed to a high state of perfection during the past year. It is obvious that the traffic interruptions are bound to increase slightly the cost of installation, but that the method is practical is evidenced by the fact that Thermit welds were installed in this way on 125th Street, New York, where the cars of the Third Avenue Railway System operate on half-minute headway. Because of the increased labor cost, this method is advocated only where the traffic cannot be taken off or where the rails cannot be welded at the side of the street and later put into place.

One large manufacturer has developed a process which includes Thermit welding for the making of frogs and switches for which very wonderful things are claimed. These units are now being shipped in large quantities, and apparently the development is very successful.

Considerable progress has been made in the use of Thermit welding in the steel mills, and this was touched upon in a paper presented at the American Iron and Steel Institute Annual Meeting in October, 1929. A very large increase in the use of Thermit welding in the steel mills

has been due not only to the proved reliability of the process for the repair of breaks, but also to the development of the use of special Thermits for the building up of worn parts, which Thermit steels resist wear for much longer periods than would new parts of similar design. This widening of the field of Thermit welding in the steel mill has been brought about through the organization of reclamation departments which coordinate the Thermit welding work in the various departments of the steel mill.

A great deal of research work has been done on the welding of long seams in the manufacture of heavy walled pressure vessels, and the results seem very encouraging. It seems obvious that there must be advantages in being able to weld the entire seam of these thick walled vessels at one time so as to avoid local distortions and locked up stresses, and this development should increase in importance as time goes on, because the industries are demanding higher temperatures and pressures which will necessitate even thicker walled vessels.

The physical properties of Thermit steels have again been improved so that the regular product which the user obtains from his Thermit reaction now has a higher tensile strength, better ductility and remarkable fatigue resistance.

Results of Research in Theory of Arc Welding Machines

A. F. DAVIS†

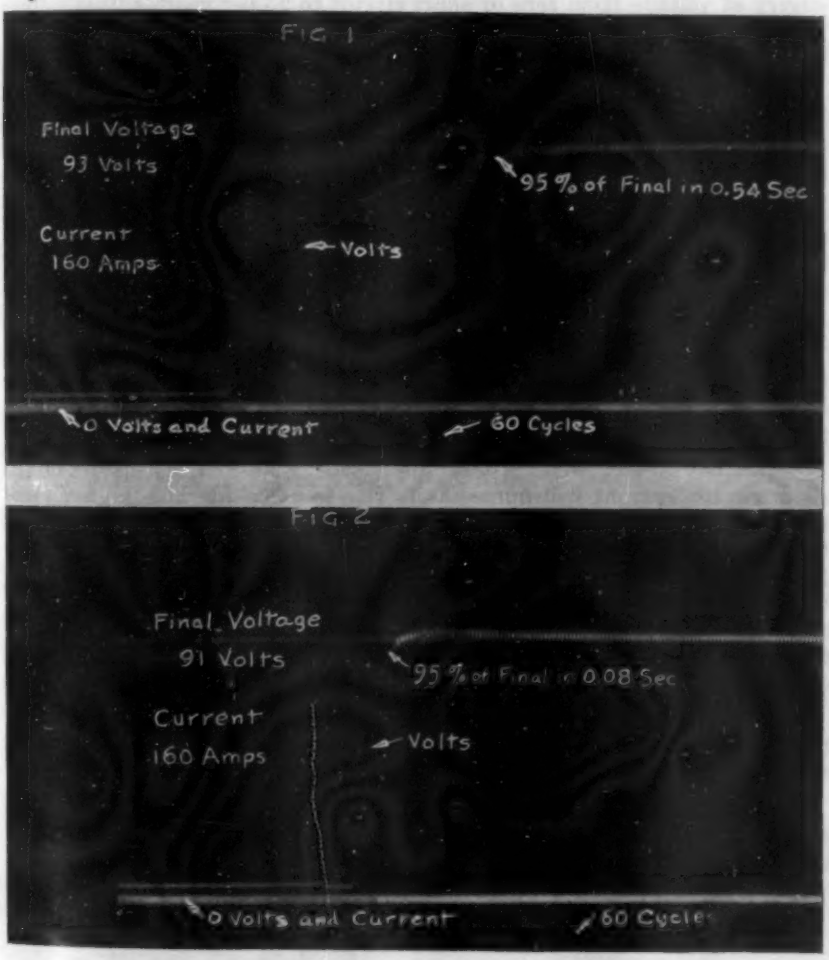
THE development of arc welding, both in design of equipment and application of the process has been so rapid that most questions which were real problems a few years ago have now been solved. However, one baffling question has been how to decrease the time for voltage recovery in direct current welding machines. By "Time of voltage recovery" is meant the length of time for the welding machine to recover full open circuit voltage from short circuit. The quicker this recovery the more nearly will voltage changes in the machine follow the voltage changes of the arc and the net result is an easier operating arc, which means more work with less fatigue and effort on the part of the operator.

While in 1927 there appeared in some technical papers an article dealing with the fundamental principles involved in reducing the amount of time it takes for a welding machine to produce its change in the voltage when welding, the research laboratories of this company began work on this question in 1924 and it now appears have a solution as a commercial possibility in the not too distant future. In fact, experiments already performed show that this time of recovery can be reduced to a minimum.

In all single operator welding machines now on the market there must be some method of reducing the open circuit voltage of the machine to the varying voltage demanded by the arc. This may be accomplished by utilizing armature reaction, varying series field or any one of a dozen

†Vice-President, Lincoln Electric Co.

or so other methods. In effect, however, the results are similar, one magnetic field of some kind opposes another. When two magnetic fields are in proximity there is produced in effect a transformer with the well-known transformer characteristics, i. e., if the current in one of the windings is changed, a voltage is immediately set up in the other winding



and this other winding will have a current flow in it as a result of the induced voltage.

It is a law of electric circuits that the induced current always flows in such a way as to nullify the magnetic effect of the inducing or original current in the first winding.

As a result of this action, ordinarily the machine will not adjust itself to the changes in the voltage of the arc as quickly as it would if the in-

ternal transformer action were eliminated. It should be understood that the changes both in the voltage of the arc and also the machine are extremely rapid, taking place in fractions of a second. Consequently, for an intelligent study of such changes it is necessary to use an oscillograph.

The oscillograph, Fig. 1, shows the length of time consumed in recovery of voltage from zero or short circuit to 95 per cent of final voltage in one of the standard machines now on the market.

The recovery shown is quite rapid and much shorter than found with the average type of machine. Various devices have been and are used to overcome the effect of this transformer action in the arc circuit. It is easily appreciated that if the nullification of this transformer effect can be accomplished inside of the machine, results would be materially better.

Experiments have shown the possibility of inserting in the arc circuit a device which will produce effects similar to those produced in the machine by the transformer action of the double winding on the pole pieces, except that the effect will be in the opposite direction, thus nullifying the original transformer action.

The oscillograph, Fig. 2, shows the results where an experimental device, such as described above, was used, and it will be noted that the length of time for the voltage to rise from zero or short circuit to 95 per cent of its final voltage is very much reduced.

Ordinarily when a welding machine is short circuited the instantaneous short circuit current will immediately rise to a considerable higher value than is desired for the best welding operation. In ordinary welding with the metallic arc, the machine is being short circuited intermittently from perhaps 15 to 30 times per second by globules of molten metal touching both the electrode and the work. These peaks of current occurring at short circuit cause considerably higher heat loss in these molten globules than is desirable, causing the globules to boil or explode. The welding operator calls this "spatter."

By nullification of the transformer effect the overshooting of the current at the time of making a short circuit is reduced and experiments show made almost zero.

The results given above and the deductions drawn are the result of a good many experiments and a very exhaustive study of arc characteristics, conducted over a period of years.

Structural Welding Code Data Applying to the United States*

This data covers

(a) 1. Cities which are reported to have adopted the American Welding Society Code for Fusion Welding and Gas Cutting in Building Construction, Part A, Structural Steel, Edition of 1928.

2. Cities which have adopted the Uniform Building Code of the Pacific Coast Building Officials Conference, which provides for welding of structural steel.

(b) Cities and towns not having provisions for welding in their Building Codes, which have permitted welding of structural steel framing erected within their jurisdiction.

(c) Cities which are revising their codes and have welding under consideration.

and including a list of welded structures in whole or in part reported to date of Dec. 31, 1929, classified as to States.

Classification (a)

1. Cities which are reported to have adopted the American Welding Society Code for Fusion Welding and Gas Cutting in Building Construction, Part A, Structural Steel, Edition of 1928.

Massachusetts

Lynn
Pittsfield

Classification (a)

2. Cities which have adopted the Uniform Building Code of the Pacific Coast Building Officials Conference, which provides for Welding of Structural Steel.†

Arizona

Prescott
Tuscon
Yuma

California

Alamenda
Alhambra
Alturas
Anaheim
Bell
Berkeley
Claremont
Compton
Corcoran
Coronado
El Monte
Fontana
Fresno
Fullerton
Laguna Beach
Livermore
Madera
Martinez
Monrovia
Monterey Park
Oceanside
Ontario
Oxnard
Pasadena
Piedmont
Pittsburg
Pomona
Redlands
Riverbank
Sacramento
San Anselmo
San Bernardino
San Fernando
San Jose
San Leandro
San Rafael
Santa Monica
Seal Beach
South San Francisco
Tujunga
Tulare
Turlock
Tustin
Ukiah
Upland
Visalia
Walnut Creek
Watsonville
Willow Glen

Louisiana

Monroe
Shreveport

*Prepared by the Committee on Building Codes of the American Welding Society.
†Reported by Prof. F. P. McKibben as of Dec. 12, 1929.

Nevada
Las Vegas

North Dakota
Grand Forks

Oregon
Eugene
Klamath Falls
Salem

Texas
Corpus Christi
Dallas

Washington
Ellensburg
Kelso

Classification (b)

Cities and towns, not having provisions for welding in their Building Codes, which have permitted welding of structural steel framing erected within their jurisdiction.

California
Emeryville
Glendale
Los Angeles
South Sacramento

Connecticut
Bridgeport
New Haven

Florida
All cities reported to permit a limited amount of welding.

Idaho
Wallace

Illinois
Decatur
Eola
Melrose Park
Waukegan

Maine
Portland
S. Portland

Massachusetts
Boston

Michigan
Detroit

Missouri
St. Louis
Kansas City

New Jersey
Atlantic City
Newark

New York
Brooklyn
Niagara Falls
North Tonawanda

Ohio
Canton
Cincinnati
Cleveland
Youngstown

Pennsylvania
Derry
East Pittsburgh
Kingston
Norristown
North Trafford
Philadelphia
Sharon

Rhode Island
Providence

Texas
Houston

Virginia
Hot Springs
Newport News

West Virginia
Wheeling

Wisconsin
Janesville
Port Washington

Classification (c)

Cities which are revising their Codes and have welding under consideration.

Alabama
Birmingham

Illinois
Chicago

Maryland
Baltimore

New York
New York City
Niagara Falls
Schenectady
Syracuse
Utica

Oregon
Portland

Pennsylvania
Philadelphia
Pittsburgh

Tennessee
Knoxville

Texas
Houston

Wisconsin
Milwaukee

Reported List of Welded Structures by States

CALIFORNIA

One-story building at Berkeley, Cal. Built by Berkeley Construction Co. Dimensions, 50 ft. by 250 ft. Has two 10-ton cranes.*

*Information supplied by Prof. F. P. McKibben.

A 60,000 sq. ft. automotive shop for the Associated Oil Co. at Emeryville, Cal., erected in 1928.*

All arc welded addition to Forest Lawn Mausoleum, Glendale, Cal. Pacific Coast Iron & Steel Co., contractors. Includes heaviest welded truss thus far built, 95-ft. span, 18 ft. high. Maximum chord stress nearly 1,000,000 lb.†

Six-story addition to Pacific Mutual Life Insurance Building, Sixth Street, Los Angeles, Cal. Consolidated Steel Corp., 1929. Field connections welded, except minor joints, which were bolted.†

Twelve-story office building, Southern California Edison Co., Los Angeles, Cal., by Consolidated Steel Corp. Work now starting. 75 to 80 per cent arc welded, balance shop riveted. Very large wind and earthquake bending stresses at column connections. About 3000 tons of steel.†

One-story warehouse, 100 ft. wide, 220 ft. long, with a 10-ft. lean-to on one side, arc welded in 1928 for Capital Rice Mills, Sacramento, Cal. Building has two main aisles on steel columns supporting roof trusses with 50-ft. spans.*

Connecticut

Shop building, 42 ft. long, 66 ft. wide, connecting existing Building 44 and 45 at Bridgeport, Conn., plant of General Electric Co. Has four trusses of 64-ft. span, supported on steel columns. Fabricated by American Bridge Co. Elected by Leak & Nelson Co., Bridgeport. Built 1928.*

Thames River Steam Power Plant of Eastern Connecticut Power Co., Montville, Conn., provided in 1929 with additional steel wind bracing arc welded by United Engineers and Constructors. Building 60 ft. wide by 147 ft. long.*

Yale University Library, New Haven, Conn., 150 ft. wide by 220 ft. long, 150 ft. high; supports for book stacks are welded. Built 1928.*

Florida

Several one-story garages and other buildings, up to 117-ft. spans, arc welded by Arch Engineering & Construction Co., of Orlando, Fla. Includes packing plant 80 ft. by 225 ft., arc welded for Seaboard Airline Ry. Co. at Winter Garden, Fla.; also a packing house 117 ft. by 202 ft.*

Idaho

Thirteen roof trusses of 50-ft. span; arc welded, 1929, Hecla Mining Co., Wallace, Idaho.*

*Information supplied by Prof. F. P. McKibben.
†Information supplied by G. D. Fish.

ILLINOIS

Roof trusses over West Yard at Decatur, Ill., plant of Mississippi Valley Structural Steel Co. Span, 84 ft.; both shop work and field splices welded.*

Mill Building, one story, built by C. B. & Q. R. R. at Eola, Ill.*

Warehouse for materials of Chicago District Plant of Mississippi Valley Structural Steel Co. at Melrose Park, Ill. Trusses, columns and crane columns are all welded. Crane, 20-ton capacity; span, 84 ft. Dimensions of building, 135 ft. by 340 ft.*

Two one-story buildings at Waukegan, Ill. Built by General Boilers Co.; one 25 ft. by 85 ft., the other 25 ft. by 50 ft.*

MAINE

Office and theater building in Portland, Me., has arc welded steel struts; built 1928 by Lehigh Structural Steel Co. of Allentown, Pa.*

One-story factory building, arc welding, 1928, by Maine Steel Products Co., South Portland, Me.; erection and welding supervised by Manchester Engineering Co., Manchester, N. H. Building 60 ft. by 200 ft., with connecting ell 25 ft. by 80 ft. Main building has one aisle 44 ft. wide with five-ton crane, and one side aisle 16 ft. wide with two-ton traveling hoist. Roof trusses and all other steel arc welded. No rivets or bolts used.*

MASSACHUSETTS

Shop Building No. 38 at Pittsfield, Mass., plant of General Electric Co. Width, 60 ft.; length, 270 ft. Three stories in part; one and two stories elsewhere. Fabricated and erected 1928 by American Bridge Co.*

MICHIGAN

One-story building constructed in Detroit, Mich., for Barnes Wire Fence Co. This structure was entirely field welded; no bolts or rivets were used.*

Steel frame of 25-story addition welded to original steel building of First National Bank Building in Detroit, Mich., 1927.*

Fifteen-story steel frame addition to J. L. Hudson Co. Department Store, Detroit, Mich. Has steel frame of 12 lower stories welded to existing building of same owner.*

Steel frame of 12-story addition welded to original steel building of People's Outfitting Co., Detroit, Mich.*

*Information supplied by Prof. F. P. McKibben.

Steel frame of four-story addition welded to original steel building of Detroit Trust Co.*

Welding employed in some connections for addition to Michigan Bell Telephone Building in Detroit.*

Additional floor welded in between original roof and original top floor of Crowley Miller & Co. Department Store, Detroit.*

Missouri

Building at St. Louis, Mo., plant of Mississippi Valley Structural Steel Co. Dimensions, 30 ft. by 50 ft. All shop work welded; field work bolted.*

Roof trusses over West Yard at St. Louis, Mo., plant of Mississippi Valley Structural Steel Co. Span 78 ft.*

Six-story building of brick and concrete built 1927-1928 by Columbian Steel Tank Co. for their own use in Kansas City, Mo., has a roof of welded tubular construction. Roof is 93 ft. by 120 ft., supported on modified bowstring welded trusses with spans of 42 ft. from center column to each side wall.*

New Jersey

Six-story steam power house of Chalfont and Haddon Hall hotels, Atlantic City, N. J., built 1928 by Bethlehem Steel Co. Building 72 ft. wide, 79 ft. long, 150 ft. high. Steel tonnage, 541. All shop work on columns welded. All field connections of beams and girders at or within three feet of columns electrically welded, as were all column splices, and connections of new steel beams to steel columns in an adjoining building. Filling-in beams bolted.*

Eight-story existing Bamberger Building, Newark, N. J., increased in height and existing columns strengthened by arc welding in 1929.*

New York

Two-story and basement bank and office building. Tonawanda Power Co., North Tonawanda, N. Y., completely welded by Fort Pitt Bridge Works, 1928. 207 tons of steel.†

Heavy shop building, No. 49, General Electric Co., Schenectady, N. Y., had existing riveted crane runways strengthened and reinforced by welding plate stiffeners to runway plate girder webs, by welding flange angles to webs, cover plates to flange angles, and by welding additional flange plates.*

Steel floor at Hershey Chocolate Co., New York City, 24 ft. by 64 ft.*

*Information supplied by Prof. F. P. McKibben.
†Information supplied by G. D. Fish.

Material shed building. Built 1920 by Electric Welding Co. of America in Brooklyn. Roof trusses, 40 ft. span; tested by Department of Buildings, City of New York. Has traveling crane.*

A 300-ton mill type building, 75 ft. by 260 ft. with a traveling crane erected by Carbide and Carbon Research Laboratories, Inc., in the plant of the Union Carbide Company, Niagara Falls, N. Y., 1929.††

OHIO

Garage building, Canton, Ohio, for Peerless Auto Sales Co. Two stories and basement. Building is 100 ft. by 150 ft.*

Roof trusses, oxy-acetylene welded at Cincinnati Prest-O-Lite plant in 1926. Spans 27 to 48 ft.*

A four-story retail store building, 60 ft. by 119 ft., erected by the Austin Company, Cleveland, built 1928. Arc welded. Steel tonnage 115. No rivets or bolts used in the steel frame.*

Main factory building of the Lincoln Electric Co., Cleveland, Ohio. Consists of three stories and a basement and has vertical members welded; constructed in 1926. Building is 50 ft. by 130 ft.*

Four stories added in 1928 to existing six-story Rose Building, Cleveland, Ohio, and old columns strengthened by arc welding. Forest City Structural Steel Co., Cleveland, fabricated, erected and welded the building.*

Building at Youngstown, Ohio, built 1926 by Youngstown Welding Co. Dimensions, 70 ft. by 220 ft., carries traveling crane. All field erection welded; no bolts or rivets used.*

PENNSYLVANIA

One-story building, Derry, Pa., built 1927 for Westinghouse Electric & Manufacturing Co., by Jones & Laughlin Steel Corp. Dimensions of building, 150 ft. by 460 ft., with a wing; 336 tons of steel.*

One-story building at East Pittsburgh Works of the Westinghouse Co. Built 1926 and 1927; 40 ft. by 100 ft.*

One-story garage at East Pittsburgh, Pa., by Westinghouse Co., in 1926; 60 ft. by 90 ft.*

Addition to chemical laboratory of Westinghouse Co. at East Pittsburgh, Pa.*

Work now starting on welded building and supporting structure for

*Information supplied by Prof. F. P. McKibben.
†Information supplied by G. D. Fish.
††Information supplied by Linde Air Products Co.

Westinghouse automatic parking station at East Pittsburgh; 110 ft. high. 125 tons of steel.†

Work now starting on group of three Westinghouse buildings, East Pittsburgh, Pa., one office type building 11 stories high, other buildings three stories and basement.†

Group of buildings from 1 to 4 stories, involving over 1000 tons of steel, heavy floor construction and about 80 roof trusses, micarta plant of Westinghouse Co., North Trafford, Pa., 1929. Jones & Laughlin, contractor.†

Five-story building at Sharon, Pa., for Westinghouse Electric & Mfg. Co. Built 1926 by American Bridge Co. Live load, 300 lb. per sq. ft.; 790 tons of steel; 70 ft. wide, 220 ft. long, 80 ft. high.*

One-story building. Built at Sharon, Pa., for Westinghouse Electric & Mfg. Co., in 1926. Building 40 ft. by 102 ft.; 27 tons of steel. Crane runway for one-ton crane.*

Shop Building No. 1, West Philadelphia, Pa., plant of General Electric Co. Approximately 1000 tons of beams, columns and trusses. Electrically welded, 1927-28. Shop, 136½ ft. wide by 551 ft. long, with a wing. Trusses 58½ ft., 77 ft., and 78 ft. spans. Has bridge cranes and wall cranes. Fabricated, erected and welded by American Bridge Company.*

Rolling-mill building at East Pittsburgh plant of Westinghouse Electric & Mfg. Co., 80 ft. by 120 ft. Roof trusses made entirely of "T" shapes. Steel tonnage, 65.*

State Armory, Kingston, Pa., had some braces inserted by arc welding in 1928.*

Five-story county office building and court house at Norristown, Montgomery County, Pa., 800 tons of steel arc welded, 1929, in field by Mellon, Taylor and Hendrickson of Philadelphia. Building 58 ft. by 201 ft. Height, 94 ft.*

Rhode Island

One-story shop, 53 ft. wide by 72 ft. long, erected 1928 in Providence, R. I., by Providence Steel & Iron Co. for its own use. Roof trusses, 53 ft. span.*

Texas

One-story garage at Dallas, Texas, built by Dallas Power & Light Co. Two units, each 16 ft. by 140 ft.*

Remodeling of the Neiman-Marcus Building in Dallas, Texas. A four-story mercantile building adjoining an existing structure wherein the

†Information supplied by G. D. Fish.
*Information supplied by Prof. F. P. McKibben.

connections to the existing structure and reinforcement of its steel were done by fusion welding.*

Three large steel hangars for Houston, Texas, municipal airport. Each hangar's arch steel frame is 75 ft. wide, 125 ft. long, and approximately 50 ft. high. All steel was arc welded in 1928. No bolts or rivets used.*

VIRGINIA

New hotel building, 180 ft. high; 60 ft. by 72 ft.; built 1928 by American Bridge Co. for Hotel Homestead, Hot Springs, Va. Eleven full stories in tower portion with smaller floors within sloping roof and cupola. Tower flanked either side by six-story wings, 40 ft. by 47 ft., 560 tons of steel, arc welded in shop and field.*

One-story steel frame building at Newport News Shipbuilding & Dry Dock Co., Newport News, Va. Building 63 ft. by 53 ft.; carries completely welded ten-ton fish belly crane.*

WEST VIRGINIA

Six-story new addition to Ohio Valley General Hospital, Wheeling, W. Va., erected by R. R. Kitchen Co., 1928, all field connections arc welded; shopwork riveted. Steel tonnage 150.*

WISCONSIN

Two additions, each a one-story building, welded to original building of Chevrolet Motor Co. at Janesville, Wis.*

Two-story boiler shop at Schueter Boiler Works, Janesville, Wis. Building 66 ft. wide by 86 ft. long. No bolts or rivets used.*

Welded trusses in Building for Modern Power Device Co. at Port Washington, Wis.*

*From information supplied by Prof. F. P. McKibben.

The Building Code Committee

of the

American Welding Society

invited other engineers to report existing or contemplated welded structures.

Specifications for Welding

Reprinted from Jan. 23, 1930, issue Iron Age

Committees Discuss Ingot Iron Plate for Pressure Vessels, Welded Pipe and Steel for Welding

VARIOUS groups of the main committee on steel of the American Society for Testing Materials met in Philadelphia, Jan. 15 to 17, to consider changes in existing specifications, new specifications, or to confer on test programs.

Ingot Iron Plates for Pressure Vessels.

One of the most important was the sub-committee on boiler steel, of which E. J. Edwards, engineer of tests, American Locomotive Co., Schenectady, N. Y., is chairman. This group has had under development for the past year a set of specifications for openhearth iron to be used for pressure vessel work.

The need for such a specification was emphasized by the Boiler Code Committee of the American Society of Mechanical Engineers. The code committee was asked to approve the use of ingot iron for unfired pressure vessels, and since the materials specifications in the various sections of the boiler code are based on those of the American Society for Testing Materials, the latter body was requested to prepare adequate specifications. It has seemed best, however, to enlarge the scope to include openhearth iron of very low metalloid content, similar products containing copper and other alloying elements, and open-hearth irons containing rather higher carbon and manganese. Such materials are made in considerable tonnage by several American producers, and all seem adaptable for the purpose indicated. Specifications for this grade of material have therefore been drafted and were scrutinized by Mr. Edwards' committee.

Specifications for Fusion Welded Pipe

Sub-committee IX on Steel Tubing and Pipe, acting on a request from the American Standards Association, discussed the advisability of working up specifications for the various kinds of pipe which have recently invaded the field in competition with butt welded or lap welded pipe or seamless steel tubing.

The Republic Steel Co., through L. B. Grindley, manager metallurgical department, Youngstown, Ohio, also presented evidence to show that pipe made by the electric resistance methods (Johnson patents) would pass all the tests required of lap welded or butt welded pipe in the "Standard Specification for Welded and Seamless Steel Pipe" (A 53-27), and requested that the wording should be amended to include the resistance welded product.

In view of the conflicting competitive situation it was decided that more

rapid progress could be made by organizing a number of groups each one charged with the responsibility of preparing specifications for a single variety of pipe; viz. (a) resistance welded, (b) hammer welded, (c) electric arc welded, (d) riveted and (e) lock-bar. The chairman, H. H. Morgan, Robert W. Hunt Co., Chicago, was therefore instructed to appoint the group leaders, and issue invitations to interested manufacturers and purchasers to participate in the work.

Steel for Welding

A sub-committee on steel for welding, under chairmanship of F. N. Speller, director department of metallurgy and research, National Tube Co., Pittsburgh, has had under consideration for the last two years a project for a specification whereunder low-carbon steel could be bought suitable for the manufacturer of piping, furniture and other products using fusion welded joints. Specifications for steel for forge or hammer welding already exist (A 78-27 and A 89-27).

As the matter developed, however, it appeared impossible to compress the matter in a single specification for two principal reasons (a) the wide range of products being welded—sheets, pipe, plate, shapes, even rails—and (b) the rapid advances being made in the technique of welding and the equipment for welding. It was generally agreed that the difficulties in making a sound joint increased as the carbon in the steel increased, and that 0.25 per cent carbon represented approximately the present line of demarcation beyond which special methods or special skill would be required. Furthermore it was agreed that seaminess, gas inclusions or other elements of quality have an important bearing on weldability into sound joints, yet these items have so far defied efforts to reduce them to specification. Lastly, it is known that the welding rod, and the technique of the welder play an important part—both matters which are being considered actively by the American Welding Society.

Consequently it was decided to report back to the main committee on steel that the following American Society for Testing Materials specifications cover steel which has been very successfully welded in quantity by present commercial fusion-welding processes:

A 7-24 Structural steel for bridges.

A 9-24 Structural steel for buildings.

A 10 and 11-24 Structural steel for locomotives and cars.

A 30-24 Boiler and firebox steel for locomotives.

A 70-27 Boiler and firebox steel for stationary service.

A 78-27 Steel plates of structural quality for forge welding.

A 89-27 Steel plates of flange quality for forge welding.

A 83-27 Lap welded and seamless steel and lap welded iron boiler tubes.

A 53-27 Welded and seamless steel pipe.

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A Reduction in Long Distance Telephone Rates

An Advertisement of the American Telephone and Telegraph Company

On January 1, 1930, there is effective a reduction in various long distance telephone rates in the Bell System which on the present volume of calls means a saving of more than $5,000,000 a year to the telephone-using public in the United States. This is the fourth reduction in long distance rates within a little more than three years. On October 1, 1926, they were reduced by $3,000,000. On December 1, 1927, a reduction of $1,500,000 went into effect. On February 1, 1929, there was a reduction of $5,000,000.

These reductions are in accordance with the aim of the Bell System to continue to furnish the best possible telephone service at the least cost to the public. Earnings must, of course, be sufficient to permit the best possible telephone service at all times and to provide a reasonable payment to stockholders with an adequate margin to insure financial safety. Earnings in excess of these requirements will either be spent for the enlargement and improvement of the service, or the rates for the service will be reduced.

This is fundamental in the policy of the management.